Annual Review of Cybertherapy and Telemedicine

Volume 6 Year 2008 ISSN: 1554-8716

Advanced Technologies in the Behavioral Social and Neurosciences

Editors:
Brenda K.Wiederhold, PhD, MBA, BCIA
Luciano Gamberini, PhD
Stéphane Bouchard, PhD
Giuseppe Riva, PhD, MS, MA

Interactive Media Institute

Annual Review of CyberTherapy and Telemedicine

Changing the Face of Healthcare

Editors-in-Chief

Brenda K. Wiederhold, PhD, MBA, BCIA
Interactive Media Institute, San Diego, CA, USA

Luciano Gamberini, PhD
Human Technology Laboratories, University of Padova, Italy

Stéphane Bouchard, PhD
Université du Québec en Outaouais, Canada

Giuseppe Riva, PhD, MS, MA
Applied Technology for Neuro-Psychology Laboratory, Istituto Auxologico Italiano, Verbania, Italy

Volume 6

Interactive Media Institute

Annual Review of CyberTherapy and Telemedicine

ISBN:
ISSN: 1554-8716

Interactive Media Institute website: www.interactivemediainstitute.com

General Information

Annual Review of Annual Review of CyberTherapy and Telemedicine (ARCTT – ISSN: 1554-8716) is published annually by the Interactive Media Institute (IMI), a 501c3 non-profit organization, dedicated to incorporating interdisciplinary researchers from around the world to create, test, and develop clinical protocols for the medical and psychological community. IMI realizes that the mind and body work in concert to affect the quality of life for individuals and works to develop technology that can be effectively used to improve the standards and and reduce the cost of healthcare delivery.

Interactive Media Institute, 6155 Cornerstone Court East, Suite 210, San Diego, CA, USA.

Telephone: (858) 642-0267, Fax: (858) 642-0285, E-mail: cybertherapy@vrphobia.com
IMI website: http://www.interactivemediainstitute.com

About the Journal
ARCTT is a peer-reviewed all-purpose journal covering a wide variety of topics of interest to the mental health, neuroscience, and rehabilitation communities. The mission of ARCTT is to provide systematic, periodic examinations of scholarly advances in the field of CyberTherapy and Telemedicine through original investigations in the telemedicine and cybertherapy areas, novel experimental clinical studies, and critical authoritative reviews.

It is directed to healthcare providers and researchers who are interested in the applications of advanced media for improving the delivery and efficacy of mental healthcare and rehabilitative services.

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Because Annual Review papers examine either novel therapeutic methods and trials or a specific clinical application in depth, they are written by experienced researchers upon invitation from our Editorial Board. The editors nevertheless welcome suggestions from our readers. Questions or comments about editorial content or policies should be directed to the editors only.

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ORIGINAL RESEARCH

CLINICAL OBSERVATIONS

Editorial

It is my sincere pleasure to welcome you to the sixth volume of *Annual Review of CyberTherapy and Telemedicine (ARCTT)*. This year's theme "Changing the Face of Healthcare" brought many new perspectives to cybertherapy while increasing the use of interactive media in training, education, prevention, rehabilitation, and therapeutic interventions. The CyberTherapy Conference series has created a forum for sharing new achievements, exchanging ideas, and showcasing the broadening horizons within our field. The critical reviews, articles, and abstracts have covered new territories in our continued growth, which have advanced the quality and future of both our conference series and the cybertherapy field.

Through the continuing evolution of the CyberTherapy Conference series, we have been successful in bringing new perspectives to CyberTherapy. It is amazing to look back over the last thirteen years to see the progression of the conference and watch its continual transformation. I am excited to see the expansion of our conference to encompass new and developing fields and opportunities in the medical arena.

I would like to take this opportunity to say thank you to all those who have helped to make ARCTT, Volume 6 possible. First, a special thanks goes to this year's editorial assistants, Brandon Lozeau, Daniel Stevens, and Brian Pham for their work in collecting and coordinating reviews for this volume. I would also like to thank this year's co-editors for their rigorous reviews of the scientific papers:, Dr. Luciano Gamberini, Dr. Stéphane Bouchard, and Dr. Giuseppe Riva.

I sincerely hope that you will find this year's volume to be a fascinating and intellectually stimulating read. I continue to believe that together we can change the face of healthcare.

Sincerely,

Brenda K. Wiederhold, Ph.D., MBA, BCIA
Editor-in-Chief

Editorial

Editorial

I have the impression that our research field, and especially the CyberTherapy Conference, is at a turning point. We started in an era where the technology was expensive, the research community was small, and the credibility of cyberpsychology applications was often questioned. These challenges to the development of our field have changed significantly. We have grown to a point where, as a community, we are facing new challenges. The number of researchers and pioneering applications are developing exponentially, but the sources for funding are not increasing at the same rate. At the same time, researchers have more and more opportunities to present or publish their research results in symposiums or scientific journals that are not specifically devoted to virtual reality and other cyberpsychology applications. Competition among researchers, a weaker need to gather together, and the increase in commercial applications of our research findings can put a significant strain on our growing community. It is my opinion that by addressing these challenges researchers and clinicians would continue to benefit from the positive synergy that characterizes our group. It is therefore important to continue striving for a balance between the promotion of studies of outstanding quality and the presentation of innovative applications that are still in the process of being empirically tested.

Papers presented in this *Annual Review of CyberTherapy and Telemedicine* illustrate the two trends mentioned above: conducting methodologically sound empirical research and developing new applications. It is important to thank the numerous anonymous reviewers who took the time to review each of the papers presented in this book and contributed to the scientific quality of this year's conference.

Stéphane Bouchard, Ph.D.
Co-Editor in chief
Chairholder of the Canada Research Chair in Clinical Cyberpsychology
Université du Québec en Outaouais

Editorial

The use of virtual reality (VR) in medicine and behavioral neurosciences has become more widespread, as highlighted by the increasing number of scientific articles published each year on this topic: searching Medline with the keyword “virtual reality”, we found that the total number of publications has increased from 45 in 1995 to 286 in 2007, showing an average annual growth rate of nearly 14 per cent.

One of the leading applications of VR in the medical field is psychotherapy, where it is mainly used to carry out exposure treatment for specific phobias (VR exposure therapy – VRE), i.e., fear of heights, fear of flying, and fear of public speaking. In VR exposure therapy, the patient is gradually confronted with the virtual simulation of feared stimuli while allowing the anxiety to attenuate.
Further applications of VR in psychotherapy include eating disorder and obesity, posttraumatic stress disorders, sexual disorders, and pain management.

Another medical field in which VR has been fruitfully applied is neuropsychological testing and rehabilitation. Here, the advantage of VR on traditional assessment and intervention is provided by three key features: the capacity to deliver interactive 3-D stimuli within an immersive environment in a variety of forms and sensory modalities; the possibility of designing of safe testing and training environments, and the provision of "cueing" stimuli or visualization strategies designed to help guide successful performance to support an error-free learning approach.

Beyond clinical applications, VR has revealed to be a powerful tool for behavioral neuroscience research. Using VR, researchers can carry out experiments in an ecologically valid situation, while still maintaining control over all potential intervening variables. Moreover, VR allows the measurement and monitoring of a wide variety of responses made by the subject.

The availability of different open source tools for developing virtual reality (Blender – http://www.blender.org; Ogre3D - http://www.ogre3d.org/; Delta 3D - http://www.delta3d.org; Yake - http://www.yake.org/) is improving the possibility of creating new applications in this area.

Furthermore, the availability of NeuroVR 1.5 (http://www.neurovr.org) - a cost-free virtual reality platform, based on open-source software, that allows non-expert users to easily modify a virtual environment and to visualize it using either an immersive or non-immersive system - allows any researcher, even if without previous experience in 3-D programming and 3-D graphics, to create their own clinical and/or research study using VR.

Giuseppe Riva, Ph.D., M.S., M.A.
Co-Editor-in-Chief

Critical Reviews

A second life for telehealth: prospects for the use of virtual online worlds in clinical psychology

Alessandra Gorini[1,2], Ph.D. candidate, Augusto Iossa Fasano, M.D., Andrea Gaggioli[1,3], Ph.D, Cinzia Vigna[1], & Giuseppe Riva[1,3], Ph.D

1. Applied Technology for Neuro-Psychology (ATN-P) Lab., Istituto Auxologico Italiano, Milan, Italy

2. Research Institute Brain and Behaviour, Maastricht University, The Netherlands

3. Interactive Communication and Ergonomics of New Technologies (ICE NET) Lab., Università Cattolica del Sacro Cuore, Milan, Italy

Corresponding author: alessandra.gorini@gmail.com

Abstract: *The diffusion of the Web 2.0 has led to the development of three-dimensional (3-D) online virtual worlds, such as Second Life, that are computer-based simulated environments mainly modelled by their users that can create and manipulate elements and thus experiences telepresence to a certain degree. Different studies suggest that virtual worlds play a critical role in contextualizing social interaction and fostering the salience of nonverbal information by providing active filtering and contingency management systems as opposed to being just the virtual equivalents of call or video conferencing systems. These features are fundamental in facilitating and making functional social interaction between users that are physically distant from one another.*
Considering the numerous advantages offered by the online virtual worlds, we suggest the use of Second Life as a support tool for traditional psychological therapies. In particular, we have developed an explorative protocol based on a single case with the aim to evaluate the potential of the virtual support sessions when, for contingent causes, patient and therapist can have only one face-to-face encounter per month. As this way to conduct psychological interventions is to be considered very innovative, our main aim was to investigate its feasibility from the side of both the patient and the therapist, analyzing their reactions to this kind of approach. Preliminary data indicate a good response both from the therapist and the patient.

Introduction

Since the introduction of the Web 2.0 in 2004 (Graham, 2005), there has been a huge increase in the potential of web applications, allowing users to create, modify and share contents using multiple computers in various locations. In particular, Web 2.0 represents the trend in the use of World Wide Web (WWW) technology aimed to enhance information sharing and collaboration between users, so that they can do more than just retrieve static information. These new features have led to the development of web-based communities, social-networking sites, wikis, blogs, and three-dimensional (3-D) online virtual worlds that represent one of the most successful applications of the Web 2.0. Three-dimensional virtual worlds are computer-based simulated environments mainly modelled by their users that can create and manipulate elements and thus experiences telepresence to a certain degree (Biocca, 1995). Such modelled worlds may appear similar to the real world or instead depict fantasy worlds, and can be used for many different aims: game and pleasure, social interaction, education, research, commercial and business, e-commerce, and so on. Usually virtual worlds admit multiple user interactions, based on text, graphical icons, visual gesture, sound and voice. Second Life, There, IMVU and Active World are some of the 3-D virtual worlds where every day millions of users interact with each other through their avatars, that is to say, three-dimensional graphical representations of themselves. Today, Second Life is the 3-D virtual world with the greater number of registered users , counting approximately 13 million of subscribers in March 2008. Everyone can download for free a client

software called the *Second Life Viewer* that enables its users, called Residents, to interact with each other through motional avatars, providing an advanced level of a social network service. Residents can explore, meet other Residents, socialize, join individual and group activities, play, create and mutually trade items and services. While Second Life and other online virtual worlds are sometimes referred to as games, this description does not fit the standard definition, since they allow a lot of various activities other than games. Within Second Life, avatars can communicate using text-based chat or voice. In particular, there are two main methods of text-based communication: local chat, and global "instant messaging". Chatting is used for public localized conversations between two or more avatars, and can be heard (seen messages) within 20 meters, while instant messaging (IM) is used for private conversations, either between two avatars, or among the members of a group and does not depend on the participants being within a certain distance from each other.

Recent experimental studies performed on avatar-based interactions in 3-D virtual worlds have shown that these kinds of virtual relations are able to convey such as feelings of social presence, that users undergo the experience of inhabiting a shared space with one or more, while their awareness of mediation by technology recedes into the background (Biocca, Harms, & Burgoon, 2003). As suggested by Casaneuva and Blake (Casanueva & Blake, 2001), the sense of social presence consists in the belief that the other subjects in the virtual environment are real and really present, and that they and the others are part of a group and process. Moreover, compared to other kinds of communicative methods, such as phone calls or chat, the avatar-based interactions significantly increase the level of social presence (G. Bente, Rüggenberg, & Krämer, 2004; G. Bente, Rüggenberg, & Krämer, 2005), elicit strong emotional responses, and increase the sense of community (Fabri, Moore, & Hobbs, 1999), even in those avatars with rather primitive expressive abilities. According to these studies, avatar platforms offer new potentials to overcome many of the restrictions related to audio and video communication modes. In particular, they suggest that virtual worlds and avatars play a critical role in contextualizing social interaction and fostering the salience of nonverbal information by providing active filtering and contingency management systems as opposed to being just the virtual equivalents of call or video conferencing systems. These features are fundamental in facilitating and making functional social interaction between users that are physically distant from one another. Through their avatars (that usually remain stable over time) users can meet friends, colleagues, students or teachers, clients and so on, and share with them a common virtual space and discuss about their interests in real time, without the necessity to reach a place somewhere in the physical world. Today, many companies, universities, organizations and private individuals use Second Life and other parallel universes to make their business and activities. Computer-generated realities are also becoming a fertile terrain for researchers and psychologists, who can analyze what people do when freed from real-world physical and social constraints (Miller, 2007).

As we have previously discussed (Gorini, Gaggioli, & Riva, 2007), 3-D online worlds are also playing an emerging role in health services as demonstrated by the diffusion of a number of Second Life medical and health education projects and communities of patients. The former have the double purpose of training medical students and educating people about health concerns, while the latter allow patients affected by specific diseases to compare their experiences, face common needs and practice specific abilities (especially in the field of certain psychological disorders). Once again 3-D online virtual worlds demonstrate to be able to provide a richer variety of tools than phone, email or chat, giving their users the possibility to communicate in a way that more closely resembles face-to-face meetings.

Considering the discussed advantages offered by the online virtual worlds, including the possibility for multiple users to share a common virtual environment at the same time, even when they are physically distant, to have digital characters that represent themselves, to communicate in real time using chat or voice in public or private way, and to experience a greater sense of presence than the one experienced using phone or chat, we suggest the use of Second Life as a support tool for traditional psychological therapies. In particular, we have developed an explorative protocol based on a single case with the aim to evaluate the potential of the virtual support sessions when, for contingent causes, patient and therapist can have only one face-to-face encounter

per month. In the last year, virtual reality has been shown to be effective in the treatment of different phobias (Gorini & Riva, 2008). Many psychologists have combined traditional cognitive-behavioural techniques with virtual therapy in order to reduce patients' fear and anxiety by correcting their cognitive distortions by exposure to specific virtual environments. In 2002, M. Kahan (Kahan, 2000) proposed to use virtual reality, not only for cognitive-behavioural oriented therapies, but also for dynamic psychotherapy drawing on psychoanalytic principles. His idea have had been previously introduced by Harris in 1994 (Harris, 1994) who theoretically discussed the potential of virtual reality experiences on our conscious beings. "Those experiences - he says - can become part of a perceptual and an emotional background that changes the way we see things. At its best, virtual reality can allow us to transcend our limitations and to expand our emotional lives". Starting from these considerations, we asked an analytic oriented psychiatrist to conduct the present experiment using Second Life as virtual setting.

As this way to conduct psychological interventions is to be considered very innovative, our main aim is to investigate its feasibility from the side of both the patient and the therapist, analyzing their reactions to this kind of approach. For this reason we will describe the characteristics of both of them, analyzing the different aspects regarding the therapeutic dyad during their interactions in the virtual world. The proposal sounds very innovative, but we would like to underline that in our view virtual therapy can be effective only if used as an adjunct to traditional therapy, or as part of an aftercare plan. For these reasons, we advise against any kind of therapy being practiced exclusively on the web because of its supportive rather than exhaustive nature. This point must be made clear to online therapy providers and the general public.

Case Report

The patient

C.B. (these are the initials of her avatar's name) is a 47-year-old woman with a scientific academic degree. She has been married since 1995 and has one 8-year-old son. In 2002 she received a diagnosis of dependent personality disorder (DSM-IV) also characterized by obsessive-compulsive traits and severe physical somatizations that needed a pharmacological treatment. C.B. is defined by her therapist as a clever and affective woman, highly motivated to deeply elaborate her insecure adult attachment style and her difficulties in forming secure adult relationships.

From 2002 to 2006 she underwent a psychoanalytic treatment based on two sessions per week that produced a significant symptomatic remission and an increasing in self and work efficiency. From the end of the psychoanalytic treatment up to now C.B. has undergone only sporadic consultation sessions, in the last few months she has expressed her therapist the desire to start a second phase of analytic-oriented treatment. At the beginning her request seemed uncompatible with her work engagement which often demanded her to move from Milan – her usual home place – to far-away destinations, in Italy and abroad.

C.B. has a basic knowledge of the main Windows applications, is not used to playing with videogames and has never experienced virtual reality systems.

Before the beginning of the study, the patient was asked to sign an informed consent.

The therapist

The therapist involved in the study, both psychiatrist and psychoanalist, is a 51-year-old man, who has matured a full experience as a trainer and a deep personal interest in studying the relationship between human mind-body and technological devices of prosthesis. He joined the project in accordance to the Freudian concept of *Junktim,* unbreakable link between clinical and research aspects. Similar to C.B., the therapist has a good knowledge of the main Windows applications, is not used to playing with videogames and has never had experiences with virtual reality systems.

He has recently changed his homeplace andlife-style, living for half a week in Milan, and the rest of the time in another Italian city, located about 300 Km from Milan. The difficulty in combining their working commitments and the physical distance (at least for half week) have been some of the reasons pushing C.B. and her therapist to try this innovative approach.

In order to guarantee that no one else other than the patient and the the therapist participate in the sessions, all the chat transcriptions were countersigned by both of them.

Assessment

In order to evaluate their imaginative abilities, their confidence with technology and virtual reality, and the sense of presence elicited by the use of Second Life, both the patient and the therapist were asked to fill out the following questionnaires:

- Betts questionnaire (adapted from: (Betts, 1909), revised by (Sheehan, 1967), and previously used in Italy by (Cornoldi et al., 1991)) (before the beginning of the protocol)
- Computer knowledge and experience questionnaire (before the beginning of the protocol)
- Barfield Presence questionnaire (Barfield & Weghorst, 1993; Hendrix & Barfield, 1996) (every 15 days from the beginning of the protocol)

The Second Life virtual office

The psychiatrist's virtual office is located inside the Eureka Island (152,184,44), a private Second Life land owened by Istituto Auxologico Italiano. The island includes a place called "experience area" in which patients can do different virtual therapeutical experiences. This area is composed of a bar, a restaurant and a house (that are interactive environments useful to treat patients suffering from alcohol or food addiction) and also includes the psychiatrist's office. This is a small house, composed of two rooms. The first one, immediately after the entrance is the place where the patient and the therapist meet each other. This area was created by a graphical expert following the suggestions of the therapist in order to obtain an appropriate therapeutic setting (see fig.1).

Different from the other island areas, this place can be accessed only by invited avatars and people not authorized are rejected. These settings can be modified only by the administrator of the island and are defined in order to guarantee the privacy of the therapeutic sessions.

The patient and the therapist interact through their avatars and communicate using the IM (instant message) channel: this is a written chat that, differently form "local chat", can be set in order to make the conversation audible only from selected avatars. All chats were recorded and automatically saved on a .txt file together with date and time.

Before the beginning of the protocol, the patient and the therapist were guided by an expert through the creation of their personal avatars, and instructed about the use of Second Life in general, and about the privacy issues in particular.

Fig.1: A screenshot taken in the Second Life therapist's office during a clinical session

Treatment schedules
The treatment was based on two virtual sessions (45 minutes each) per week plus one face to face session per month. The patient and the therapist agree on date and time of the virtual appointments with the same modalities they use for real ones.

Technical requirements
For system requirements for Windows, Mac OS and Linux refer to: http://secondlife.com/corporate/sysreqs.php.
Both the therapist and the patient use a laptop with Windows as operating system and a DSL internet connection.

Quantitative data
The Betts questionnaire reveals that the therapist has slightly higher imaginative abilities (43/70) than the patient (39/70). Imaginative abilities are usually correlated with high sense of presence.
The computer knowledge and experience questionnaire, administered before the beginning of the protocol, shows that the level of experience in computer managing is "sufficient" (2/5) for C.B. and "good" (3/5) for the psychiatrist, and that both of them have had at least one previous experience with stereoscopic images. They have never played with videogames and none of them have ever used a virtual reality system and know how it works.
Their scores regarding the sense of presence are reported in table 1.

Qualitative observations
Due to technical problems the trial started later than we planned, so up to date we have only a few sessions available, but we argue that they are enough to make some preliminary qualitative observations.

Since neither the therapist nor the patient were experts in computer applications, the first virtual appointment was characterized by a certain degree of slowness that was easily ridden out in the following sessions. Analyzing the text-chats obtained from the different sessions, the psychiatrist noticed that their formal aspects and the relation style of the virtual interactions are comparable to those observed during the face-to-face sessions. Starting from the first session, the patient conveys her emotional contents and reactions, makes free associations, reports her recent dreams and expects the therapist's interpretation exactly with the same expressive modalities she uses when she is sitting in front of him. Apparently, there are no signs of inhibition caused by the presence of a technological medium between the therapist and the patient. The "fundamental rule" of psyhoanalysis that urges that patients say "whatever comes into their heads, even if they think it unimportant or irrelevant or nonsensensical…or embarrassing or distressing" (Freud's Psycho-Analytic Procedure" (1904a [1903]p. 251) is respected.

Forcing the physical distance between the therapist and the patient, the virtual setting also represents a good opportunity to practice, at least from a physical point of view, another important analytic rule: the "rule of abstinence". This rule designates a number of technical recommendations that Freud stated regarding the general framework of the psychoanalytic treatment, including, for example, the prescription to have no physical or gaze contacts with the patient. The therapist refers that the application of the abstinence rule in the virtual setting does not interfere with the therapeutic relationship, since they have already practiced it during the traditional sessions. On the contrary, it could contribute to maintain a favorable tension potential, which is assumed to keep the therapeutic process in motion.

Another important point regards the constancy of the setting: virtual reality offers the therapist the

Questions	C.B.	Psychiatrist
If your level in the real world is 100, and your level of presence is 1 if you have no presence, rate your level of presence in this virtual world.	50	60
How strong was you sense of presence, "being there", in the virtual environment (1-5 scale)	3	3

Table1: The Barfield Presence Questionnaire

possibility to create a therapeutic environment more stable than any other real physical setting, other than to maintain the avatar's aspect unchanged over time. Starting from the very first sessions, the therapist and the patient meet each other always in the same place, recognizing their respective avatars as the "virtual incarnation" of their real interlocutor.

The only critical point emerged during the virtual sessions regards the patient's concern about privacy. A certain number of times she asked the therapist the following question: "Doctor, are you sure we are alone?". This doubt did not really invalidate the session, since immediately after the therapist's answer it was regularly performed.

Conclusions

Even if we have had the opportunity to analyze and discuss only the results coming form few virtual sessions, we can draw some preliminary positive conclusions about this innovative experience. Both the therapist and the patient have experienced a quite high sense of presence and have not found particular problems or limitations in the use of Second Life as therapeutic setting. On the contrary, analyzing what the patient said, and listening to the psychiatrist's comments, it seems that the physical barriers imposed by the virtual setting contribute to knocked down the psychological resistences that tend to emerge during face-to-face interactions. As discussed above, this is not just an experimental protocol, but also a way to allow the patient to have frequent meetings with her therapist, that would not be possible if they were forced to meet twice a week somewhere in a physical place. If we will be able to demonstrate the effectiveness of this approach, its potentialities could be enormous, especially for all patients who have difficulties to physically reach their therapists, such as those with specific mental, physical or social disabilities. In the mean time, we will go further with the present protocol in order to obtain more quantitative and qualitative data that allow us deeper and more objective remarks.

Obviously, it is not our intention to overly simplify one of the most controversial issues related to the emergence of the Web 2.0 and its application to health care concerns. The use of Internet to provide mental health services is controversial and in the ongoing debate about both the value and ethics of therapeutic virtual environments there are proponents at both extremes. Some conceive of technology as means to a bright future where anyone's emotional needs can be instantaneously addressed; others are obstinately opposed to the use of distance psychology for any kind of intervention. With these very preliminary data, we hope to engender a constructive debate in the scientific community headed for a better understanding of the potential of virtual reality in the treatment of psychological disorders.

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Evaluation Studies

Neuropsychological assessment of attentional processing using virtual reality

Thomas D. Parsons, Ph.D and Albert A. Rizzo Ph.D

Institute for Creative Technologies, University of Southern California

tparsons@usc.edu

Abstract: *Attention processes are the gateway to information acquisition and serve as a necessary foundation for higher-level cognitive functioning. The Virtual Reality Cognitive Performance Assessment Test (VRCPAT) focuses upon refined analysis of neurocognitive testing using a virtual environment to assess attentional processing and recall of targets delivered within the context of a virtual city and a virtual driving simulation. The 15 minute VRCPAT Attention Module and a 1.5 hour neuropsychological assessment were conducted with a sample of 12 healthy adults, between the ages of 21 and 36, that included equivalent distributions of men and women from ethnically diverse populations. No subjects had history of psychiatric or neurologic conditions. To examine scenario differences, one-way ANOVAs were performed, comparing attentional performance in simple stimulus presentations (Mean = 43.63; SD = 8.91) versus complex stimulus presentations (Mean = 34.63; SD = 6.86). The results indicated that the increase in stimulus complexity caused a significant decrease in performance on attentional tasks (F = 5.12; p = 0.04). To examine scenario differences, we compared attentional performance in low intensity (Mean = 40.01; SD = 4.06) versus high intensity (Mean = 9.25; SD = 3.70) presentations. The results indicated that the increase in stimulus intensity caused a significant decrease in performance on attentional tasks (t = 9.83; p = 0.01). Findings suggest that the increase in stimulus complexity and stimulus intensity within a virtual environment can manipulate performance on attentional tasks.*

Introduction

Attention processes are the gateway to information acquisition and serve as a necessary foundation for higher-level cognitive functioning. Current methods for assessing attention performance include traditional paper and pencil tests, motor reaction time tasks in response to various signaling stimuli, flatscreen computer–delivered approaches, and behavioral rating techniques. These approaches have been criticized as limited in the area of ecological validity. While standard neuropsychological measures have been found to have adequate predictive value, their ecological validity may diminish predictions about real world functioning (Chaytor et al., 2006; Farias, Harrell, Neumann, & Houtz, 2003; Gioia & Isquith, 2004; Odhuba et al., 2005). Traditional neurocognitive measures may not replicate the diverse environment that in which persons live. Additionally, standard neurocognitive batteries tend to examine isolated components of neuropsychological ability, which may not accurately reflect distinct cognitive domains (Parsons et al., 2005).

Virtual Reality (VR) technology is increasingly being recognized as a useful tool for the study, assessment, and rehabilitation of cognitive processes and functional abilities. The ability of VR to create dynamic, immersive, three-dimensional stimulus environments, in which all behavioral responding can be recorded, offers assessment and rehabilitation options that are not available using traditional assessment methods. In this regard, VR applications are now being developed and tested which focus on component cognitive processes including: attention processes (Parsons et al., in press; Rizzo et al., 2006), spatial abilities (Parsons et al., 2004), memory (Matheis et al., 2007), and executive functions (Baumgartner et al., 2006; Elkind et al., 2001). The increased ecological validity of neurocognitive batteries that include assessment using VR scenarios may aid differential diagnosis and treatment planning. Basic attention abilities have been addressed using VR with success and the assessment requirements for attention and other cognitive processes appear well matched to a comprehensive VR approach. Within a head mounted display-delivered virtual environment, it is possible to systematically present cognitive

tasks targeting neurocognitive performance beyond what are currently available using traditional methods.

The Attention Module found within the Virtual Reality Cognitive Performance Assessment Test (VRCPAT) focuses on the refined analysis of neurocognitive testing using a virtual environment to assess attentional processing within the contexts of 1) Fixed Position in the Virtual City Test; and 2) HUMVEE Attention Task scenario. In the "Fixed Position in the Virtual City Test" scenario subjects were given both a selective attention and a working memory task. In the "HUMVEE Attention Task" scenario, attention was assessed within both "safe" and "ambush" settings: start section; palm ambush; safe zone; city ambush; safe zone; and bridge ambush. The task involved the presentation of a four-digit number that was superimposed on the virtual windshield (of the Humvee) while the subject drove the Humvee. Herein we report on scenario differences: 1) comparison of attentional performance in simple stimulus presentations versus complex stimulus presentations; and 2) comparison of attentional performance in low intensity versus high intensity stimulus presentations.

Methods

Participants:
The study sample included 12 healthy subjects (Age, mean = 26.71, SD = 4.49; 50 % male; and Education, mean = 15.50, SD = 2.54). Strict exclusion criteria were enforced so as to minimize the possible confounding effects of comorbid factors known to adversely impact cognition, including psychiatric (e.g., mental retardation, psychotic disorders, diagnosed learning disabilities, Attention-Deficit/Hyperactivity Disorder, and Bipolar Disorders, as well as substance-related disorders within two years of evaluation) and neurologic (e.g., seizure disorders, closed head injuries with loss of consciousness greater than 15 minutes, and neoplastic diseases) conditions. Subjects were comparable in age, education, ethnicity, sex, and self-reported symptoms of depression.

Procedure:
The University of Southern California's Institutional Review Board approved the study. Experimental sessions took place over a two hour period. After informed consent was obtained, basic demographic information and computer experience and usage activities were recorded. Subjects then completed a neuropsychological battery administered under standard conditions. Following completion of the neuropsychological battery, subjects completed the simulator sickness questionnaire (Kennedy, Lande, Berbaum, & Lilienthal, 1992), which includes a pre-VR exposure symptom checklist. Next, all participants were administered the VRCPAT as part of a larger neuropsychological test battery.

Neuropsychological Battery:
The following traditionally used paper and pencil neuropsychological measures were used: To assess Attention we used Digit Span (Forward and Backward) from the Wechsler Adult Intelligence Scale –Third edition (WAIS-III; Psychological Corporation, 1997). To assess processing speed we used Digit Symbol Coding from the Wechsler Adult Intelligence Scale –Third edition (WAIS-III; Psychological Corporation, 1997), and Trail Making Test Part A (TMT; Heaton, Grant, & Matthews, 1991; Reitan & Wolfson, 1985). To assess executive functioning we used Trail Making Test Part B (TMT; Heaton, Grant, & Matthews, 1991; Reitan & Wolfson, 1985) and the Stroop Color and Word Test (Golden, 1978). To assess verbal learning and memory we used the Hopkins Verbal Learning Test – Revised (HVLT-R; Brandt & Benedict, 2001); to assess nonverbal learning and memory we used the Brief Visuospatial Memory Test – Revised (BVMT-R; Benedict, 1997); and to assess Lexical-Semantic Memory we used Controlled Oral Word Association Test (FAS: Benton, Hamsher, & Sivan, 1994); 2) Semantic Fluency (Animals; Gladsjo et al., 1999).

Virtual Reality Measures: The following two VR-based attentional measures were designed and evolved following iterative user testing: 1) Fixed Position in the Virtual City Test (See Figure 1); and 2) Humvee Attention Task.

Figure 1: Fixed Position in the Virtual City

Figure 2: Humvee Attention Task

Fixed Position in the Virtual City Test: In this scenario subjects were given both a selective attention and a working memory task. For the selective attention portion, each subject listened to a virtual trainee as the trainee classified passing vehicles. For the evaluation, the virtual trainee reported either "US military", "Iraqi police", "Iraqi civilian" or "possible insurgent". The subject was to tell the new recruit whether he was correct or incorrect. For the working memory portion, subjects were presented a series of single digit numbers. Subjects listened for the first two numbers, added them up, and reported the answer to the examiner. When the subject heard the next number, s/he added it to the one presented right before it. Subjects continued to add the next number to each preceding one. Subjects were not being asked to give examiner a running total, but rather the sum of the last two numbers that were presented. For example, if the first two numbers were '5' and '7,' subject would say '12.' If the next number were '3,' subject would say '10.' Then if the next number were '2,' subject would say '5' because the last two numbers presented were 3 and 2. See Table 1 for descriptives.

Table 1 Attention Descriptives for the Fixed Position in the Virtual City Test

	Mean	Std.Dev.	Minimum	Maximum
Baseline # correct classifications	12.00	0.00	12.00	12.00
Trial 1 # correct classifications	21.55	0.69	20.00	22.00
Trial 2 # correct classifications	19.36	1.36	16.00	21.00
Trial 3 # correct classifications	20.45	0.52	20.00	21.00
Baseline correct additions	8.82	1.40	5.00	10.00
Trial 1 correct additions	17.73	1.74	15.00	20.00
Trial 2 correct additions	16.64	2.84	10.00	19.00
Trial 3 correct additions	17.00	3.44	7.00	19.00
Total of all the classifications	73.36	1.86	70.00	76.00
Total of all the additions	60.18	7.10	43.00	67.00
Total of everything	133.55	6.83	116.00	140.00

Note: For all analyses, N=12.

HUMVEE Attention Task: The Humvee scenario assessed attention within both "safe" and "ambush" settings: 1) start section; 2) palm ambush; 3) safe zone; 4) city ambush; 5) safe zone; 6) bridge ambush. The task involved the presentation of a four-digit number that was superimposed on the virtual windshield (of the Humvee) while the subject drove the Humvee. Each four-digit number was presented for approximately 300 ms and was randomly selected by the computer from a database of prescreened numbers. Subjects were required to say the number out loud immediately after it appeared on the screen while the Humvee continued driving. An examiner will recorded the responses. See Table for descriptives of Humvee Attention Test.

The design consists of six Humvee attention conditions:

1. *Fixed Position: 2.0 second condition (Start Section):* In this condition, the four-digit number always appeared in a *fixed central* location on the "windshield." The numbers were presented at 2.0 second intervals. This occurred in the "Start Section" and ended just before the "Palm Ambush."
2. *Fixed Position: 1.5 second condition (Palm Ambush):* The procedure for this condition was identical to the "Fixed Position" condition described previously except that the numbers were presented at 1.5 second intervals. This occurred in the "Palm Ambush" section and ended just before the "Safe Zone" section.
3. *Fixed Position: 0.725 second condition (Safe Zone):* The procedure for this condition was identical to the "Fixed Position" condition described previously except that the numbers were presented at 0.725 second intervals. This occurred in the "Safe zone" and ended just before the "City Ambush" section.
4. *Random Position: 2.0 second condition (City Ambush):* The procedure for this condition is similar to the "Fixed Position" condition with the exception that the numbers appear *randomly* throughout the "windshield" rather than in one fixed central location. The numbers were presented at 2.0 second intervals. This occurred in the "City Ambush" and ended just before the "Safe Zone".
5. *Random Position: 1.5 second condition (Safe Zone):* The procedure for this condition is similar to the preceding "Random Position" condition except that the numbers were presented at 1.5 second intervals. This occurred in the "Safe Zone" and ended just before the "Bridge Ambush".

Random Position: 0.725 second condition (Bridge Ambush): The procedure for this condition is similar to the preceding "Random Position" condition except that the numbers were presented at 0.725 second intervals. This occurred in the "Bridge Ambush".

Table 2: Descriptives for the HUMVEE Attention Task

	Mean	Std.Dev.	Minimum	Maximum
Simple 2.0 (Start Section--safe zone1)	18.70	1.83	15.00	20.00
Simple 1.5 Palm Ambush	17.20	3.91	9.00	20.00
Simple .725 Safe Zone 2	6.60	3.95	1.00	13.00
Complex 2.0 (city ambush)	13.70	1.57	11.00	16.00
Complex 1.5 safe zone 3	13.20	4.37	4.00	18.00
Complex .725 bridge ambush	7.10	3.60	3.00	14.00
Total of all the Simples	42.50	8.54	24.00	53.00
Total of all the Complex	34.00	6.55	26.00	43.00
Total of all the ambush	38.00	7.62	24.00	47.00
Total of all the safe zones	38.50	8.09	26.00	49.00
Total of all humvee	76.50	14.08	53.00	94.00

Note: For all analyses, N=12.

Results

To examine scenario differences, one-way ANOVAs were performed, comparing attentional performance in simple stimulus presentations (Mean = 43.63; SD = 8.91) versus complex stimulus presentations (Mean = 34.63; SD = 6.86). The results indicated that the increase in stimulus complexity caused a significant decrease in performance on attentional tasks ($F = 5.12$; $p = 0.04$). To examine scenario differences, we compared attentional performance in low intensity (Mean = 40.01; SD = 4.06) versus high intensity (Mean = 9.25; SD = 3.70) presentations. The results indicated that the increase in stimulus intensity caused a significant decrease in performance on attentional tasks ($t = 9.83$; $p = 0.01$). Given the small sample size, we decided to not assess the construct validity of the VRCPAT Attention Modules. Hence, no attempts were made to assess correlations between standard paper and pencil tests and VRCPAT. See Table 3 for descriptives of standard paper and pencil tests.

Discussion

Our goal was to conduct an initial pilot study of the general usability of the VRCPAT Attention Module scenarios. We aimed at assessing whether the increase in stimulus complexity would result in a significant decrease in performance on attentional tasks. We also wanted to see whether an increase in stimulus intensity would result in a significant decrease in performance on attentional tasks. We believe that this goal was met as the study results indicated that: (1) the increase in stimulus complexity caused a significant decrease in performance on attentional tasks; and 2) the increase in stimulus intensity caused a significant decrease in performance on attentional tasks.

Our findings should be understood in the context of some limitations. First, these findings are based on a fairly small sample size. As a necessary next step, the reliability and validity of the test needs to be established using a larger sample of participants. This will ensure that the current findings are not an anomaly due to sample size. Additionally, the diagnostic utility of this attention assessment tool must be determined. The ability of the VRCPAT's Attention Module to accurately classify participants into attention impaired and attention intact groups based on carefully established critical values must be evaluated. This will involve the generation of specific cut-off points for classifying a positive or negative finding. The VRCPAT Attention Module's prediction of attentional deficits will need to be evaluated by the performance indices of sensitivity, specificity, predictive value of a positive test, and predictive value of a negative test.

In sum, manipulation of stimulus complexity and intensity in the VRCPAT's Attention Module caused a significant differences in performance on attentional tasks. Complementary comparisons of the VRCPAT's Attention Module with behavioral and neurocognitive tests developed to assess attentional processing are also warranted to determine the construct validity of the test.

Table 3: Descriptives of Paper and Pencil Neuropsychology Tests.

	Mean	Std.Dev.	Minimum	Maximum
Hopkins Verbal Learning Test (Learning)	29.80	3.58	24	35
Hopkins Verbal Learning Test (Recall)	10.89	1.54	8	12
Brief Visuospatial Memory Test (Learning)	29.00	3.02	23	34
Brief Visuospatial Memory Test (Recall)	10.60	0.97	9	12
Trail Making Test Part A	23.33	10.12	14	48
Trail Making Test B	50.33	5.55	41	57
Stroop Interference	93.10	17.55	69	125
WAIS Letter-Number-Sequencing	14.60	3.27	11	20
WAIS Digist Span Forward	12.70	2.54	9	16
WAIS Digist Span Backward	11.30	2.54	8	13
WAIS Digit Symbol Coding	83.00	17.92	54	107
Semantic Fluency	27.00	6.6	18	37
Letter Fluency	47.67	6.6	33	57

Note: For all analyses, N=12.

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Extending the media equation to Emotions: an approach for assessing realistic emotional characters

Ariel Beck[†], PhD Candidate, Brett Stevens*, Ph.D., Kim A. Bard, Ph.D.**.*

**Department of Creative Technologies, Portsmouth University, UK*
[†]Expert Centre, Portsmouth University, UK
***Centre for the Study of Emotion, Department of Psychology, Portsmouth University, UK*

ariel.beck@port.ac.uk

Abstract: *Computer-based simulation has demonstrated effectiveness for medical training (Anolli, Vescovo, Agliati, Mantovani, & Zurloni, 2006). These types of simulation have used emotional animated characters. Even though emotions have a strong influence on human-human interactions (Gratch, Mao, & Marsella, 2006), typical system evaluation does not assess how the emotional display is perceived by observers. In medical interview training such animated characters would have to be perceived as social and emotional partners so that trainees would be confronted with situations comparable to real life ones. However, it is not known how appropriate the perception to a realistic emotional animated character is. Using a similar approach as the one proposed by Nass et al in their work on the Media Equation (Nass & Moon, 2000), this paper proposes a research method for assessing the interpretation of an emotional animated character.*

Introduction

Computer based simulation has demonstrated effectiveness for complex training (Anolli et al., 2006). These types of simulation use emotional animated characters portraying realistic scenarios. Examples range from "the mission rehearsal exercise", which is a Virtual Environment (VE) for training military personnel going to serve in Iraq (Swartout et al., 2006), to FearNot, a VE for educating children on the issues of bullying (Aylett, Paiva, Woods, Hall, & Zoll, 2005). One of the advantages of VE training is that it induces a feeling of presence, the feeling of being there (Slater, 2003). This feeling of presence helps trainees experience the situation in ways that make it more comparable to real life situations.

Altough VEs use emotional animated characters, typically using computational models for emotion (Aylett et al., 2005; Swartout et al., 2006), system evaluation does not assess how the emotional display is perceived by observers. However, emotions have a strong influence on human-human interactions (Gratch et al., 2006) and it is important to efficiently reproduce these interactions, so that the animated characters display emotions as humans do, i.e. through voice, facial expressions and body language. Such character could potentially be used as an efficient tool for medical interview training, including competences such as empathy, emotional coping, non verbal communication management, reassurance. The problem is that it is not known how similar the perception of a realistic emotional animated character is with real-life situations. A difference though would exclude simulation as a training tool for medical consultations where the understanding of emotional cues is essential. Hence, investigations are needed to focus on how emotions are perceived and interpreted when displayed by animated characters.

Assessing users' emotional interpretation is extremely complex as it varies from one situation to another: different societies have different norms and different persons may appraise a situation very differently, which would result in different emotional states (even within the same society) (Niedenthal, Krauth-Gruber, & Ric, 2006). It is generally not possible to fully understand this process. However, they method that similar interpretations of a realistic emotional animated character are with real-life situations can be investigated using a similar approach as that proposed by Nass and Moon (2000) in their work on the Media Equation. Therefore, this paper begins with a discussion of how the Media Equation can be applied to animated emotional displays, and

ends with a proposal for a research method to investigate how the emotions of an animated character are interpreted.

Extending the Media Equation to Animated Display of Emotions

Research has investigated how humans interact with technology from a social perspective, ultimately leading to the Media Equation (Reeves & Nass, 1996). Nass et al used existing results from experimental social psychology that defined rules that apply to Human-Human interaction (Reeves & Nass, 1996) and investigated whether these rules apply to Human-Computer interaction as well. Their work showed that the way humans interact with technology is 'mindlessly' social. They found technology can trigger social scripts, which typically apply to human-human interaction but are inappropriate for human-computer interaction, as they ignore the essential nature of the technology (Nass & Moon, 2000). The social rules tested include perceived expertise, as media content tend to be rated more favourably when displayed via technology labelled as 'specialist'. Similar experiments demonstrated that computers can be considered as teammates, prompting the activation of social rules governing such a relationship. Another striking example is politeness towards computers, where *"Adults have been shown to apply the same social norms and rules of etiquette toward computers as they do toward other humans"* (Aharoni & Fridlund, 2006). Consistent with the Media Equation, other studies support the fact that animated characters are indeed perceived as social agents and triggers natural and social protocols of human users, such as gaze (Prendinger, Ma, & Ishizuka, 2007) or different acceptance levels of animated character's recommendations based on ethnicity (Pratt A, Hauser, Ugray, & Patterson, 2007).

These experiments support the Media equation even within very restricted technologies (Table 1) and show that users exhibit what the authors called mindless social reactions; however, when subjects are asked whether their reactions towards the technology were social their answers were constantly negative (Nass & Moon, 2000). Therefore, "The Media Equation" did not remain true on a general basis as media is not consciously considered as a social partner (Nass & Moon, 2000). However, this was with restricted technology and may not hold true for highly realistic characters that can use all the features used in face-to-face interaction (Cassell, 2000).

Exploring if an animated character would be consciously perceived as social partner can be achieved by testing the implicit assumption in developing hyper-real characters, that viewers would perceive and interpret humans and animated characters in a similar way. Moreover, a similar approach can be adapted by testing the ability to perceive (i.e. see) and interpret (i.e. attribute meaning) emotional expressions when displayed through the body (Pichon, De Gelder, & Grèzes, 2007). This emotional body language is an ideal start to an investigation as it is known that people can accurately distinguish among emotions when displayed through human body language (den Stock, Righart, & de Gelder, 2007).

Methodology

Exploring if the media equation held true at a conscious level for animated characters can be done by testing the implicit assumption in developing hyper-real characters, that viewers would perceive and interpret a human's or animated character's body language in a similar way (i.e. classify a displayed emotion correctly). If an ani-

	Mindlessly perceived as social partner	**Consciously perceived as social partner**
Realistic Characters	YES (Prendinger et al., 2007) (Pratt A et al., 2007)	?
Restricted Technology	YES (Nass & Moon, 2000) (Aharoni & Fridlund, 2006)	NO (Nass & Moon, 2000)

Table 1: Summary of the Media Equation results.

mated emotion is not classified accurately by a viewer, it could have resulted from a misperception of the cues themselves (an incomplete or erroneous set of cues is seen) or the cues are not experienced (perceived or interpreted) at the intended intensity. This could result in a misinterpretation of the perceived cues (they are interpreted as resulting from a different cause, either a different emotion, or simply as the results of an algorithmic loop, and not of a deeper emotional existence). However, it may also be that viewers perceive the animated movement as unnatural, which ultimately makes the entire experience appear unbelievable.

Accurate classification is an important part of medical interview training though, as the viewers need to learn how to read and adapt to the patients' emotional states. Thus, conscious perception needs to be established in terms of accuracy and naturalness, if believability is to be maintained. If realistic animated displays of emotion are not 'truly' interpreted in these ways, it may result in biased skill development that is not transferable to real world situations. The assumption that viewers would perceive and interpret a human's or animated character's body language in a similar way is currently being investigated by using a set of emotional performances recorded using Motion Capture Technology (motion capture technology accurately capture an actor's gestures which can then be used to animate a character's whole performance). This is then used to compare viewers' perception and interpretation of the same emotional body language displayed either by a human or by an animated character using a within-subjects design with two conditions (Actor and Animated).

Material

A professional actor and a professional director were hired to build the material. They performed the following emotions: Anger, disgust, shame, fear, sadness, surprise, relief, happiness, pride, excitement. Each emotion was performed in two different ways, a natural version and a stylised one comparable to the one that can be seen in traditional animation. To ensure equivalency across conditions, the actor was video recorded (Fig1 A) and motion captured simultaneously. The motion capture data was then used to animate a character (Fig1 B) so that it displayed exactly the same body language. The faces of actors and animated characters' were pixelated, so that it removes this source of information and also removes the possible uncanny effect that may come from poor facial animations. Moreover, to remove possible effects, such as differences in dress of the actor and animated character, both appeared in a motion capture suit (Figure 1) and are physically similar (skin and face are not visible).

In order to record the viewer's interpretation of the emotional body language displayed, an existing questionnaire has been modified. It is based on the Geneva Emotional Wheel (Bänziger, Tran, & Scherer, 2005). The Geneva Emotional Wheel is usually used for self report (i.e. participants reporting their own emotional state), however is has been modified to report on the classification

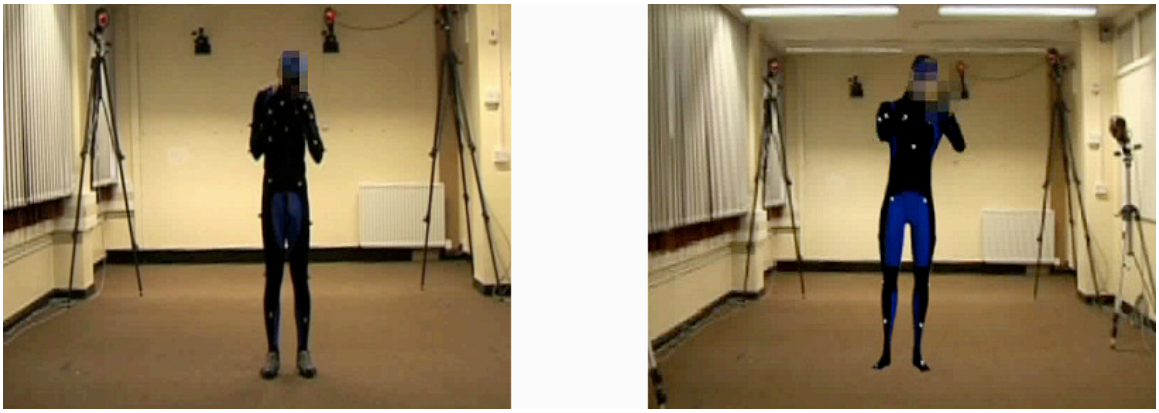

Figure 1: Screen shots of video condition (A) and animated condition (B).

of emotional display for this study. Therefore, the wheel's centre now includes two additional options, "no emotion at all" and "none of the above", in case a different emotion is recognised by a participant. Each participant is also asked to indicate the strength for every emotional clip (five point Lickert scale radiating out from the centre).

These videos and animations are displayed on a 5m x 2.5m rear projection screen at life size. To measure the viewer's ability to understand the expressive cues displayed, the material is embedded into custom made software, which is used for displaying the video clip as well as recording the participant's answers.

The study has just started and the results cannot be statistically analyzed yet. Table 2 gives an example of a response set for one participant. As highlighted in bold there are many unexpected differences in the interpretation. However, at this stage it is not possible to conclude on the exact causes of these differences: It is possible that Human and Animated Characters are interpreted differently when they display the same body language, however it may also be due to the fact that some emotions are impossible to recognize seeing only body language, thus resulting in different interpretations.

Performance Number	Interpretation of the Actor Condition	Strength	Interpretation of the Animated Condition	Strength
1	Contempt	4	Contempt	3
2	Anger	5	Anger	5
3	**None Above**	**x**	**Anger**	**2**
4	**Disgust**	**3**	**None Above**	**x**
5	**Anger**	**4**	**Disgust**	**4**
6	**Excitement**	**4**	**Happiness**	**4**
7	Wonderment	4	Wonderment	4
8	**None Above**	**x**	**Anger**	**2**
9	**Anger**	**2**	**Contempt**	**3**
10	**Enjoyment**	**5**	**Happiness**	**4**
11	**Pity**	**2**	**No Emotion**	**x**
12	Pride	4	Pride	4
13	**Disappointment**	**4**	**Relief**	**4**
14	Disappointment	4	Disappointment	5
15	Sadness	5	Sadness	3
16	Disappointment	5	Disappointment	4
17	**Sadness**	**2**	**No Emotion**	**x**
18	**Shame**	**2**	**None Above**	**x**
19	**Interest**	**3**	**Anger**	**2**
20	**Anger**	**3**	**Contempt**	**4**

Table 2: Interpretation of the display in both conditions

Conclusion

This paper highlights an issue in the development of hyper realistic animated character. Though research efforts focus on building animated characters that would behave hyper realistically, it is not known how similar the perception and reaction to a realistic emotional animated character are with a real person. Differences could exclude simulation as a training tool for medical consultations where understanding and consideration of emotional cues is essential.

A research proposal for investigating this issue has been developed. It is important to emphasize that it is only if humans react to animated characters in a similar way as they do towards others humans that animation could be used as an efficient tool for medical interview training, including competences such as empathy, emotional coping, non-verbal communication management and reassurance.

Acknowledgements

This project is funded by the ExPERT Centre at the University of Portsmouth as part of a PhD programme. The authors would like to thank Dr. Christina Howell Richardson for her advice and support. Kim A. Bard was partially supported by FEELIX GROWING, an European Commission FP6 project, IST-045169.

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Implementation of FACS for synthetic characters for use in studying facial expression recognition by survivors of childhood cancer

Robert C. Hubal (1), Ph.D., Noah R. Evens (1), David P. FitzGerald (2), Ph.D., Kristina K. Hardy (2), Ph.D., Victoria W. Willard (2), & Melanie J. Bonner (2), Ph.D.

(1) RTI International, Research Triangle Park, NC, USA
(2) Duke University Medical Center, Durham, NC, USA

Corresponding author:
Robert Hubal
RTI International
3040 Cornwallis Road
Research Triangle Park, NC 27709-2194
919/541-6045
919/541-6965 (fax)
rhubal@rti.org

Abstract: *A significant portion of pediatric cancer survivors will experience cognitive, academic, and social difficulties that limit their quality of survival well into adulthood. Of these, the least is known about the nature and extent of survivors' social problems. What is known about survivors' difficulties with nonverbal processing implies that their social lives may be hindered by problems with nonverbal aspects of social communication (e.g., interpreting facial expression, body language, tone of voice). Because of limitations inherent to current methodology and measurement, however, important information about the link between survivor's nonverbal deficits and their social functioning is unknown. As part of a set of studies to assess deficits associated with poor social functioning in childhood cancer survivors as compared to healthy children, we are developing a new instrument involving a facial expression recognition task. Our instrument employs Facial Action Coding System action units to systematically manipulate facial expressions, and an easy-to-use interface for the target pediatric population.*

Background and Significance

Despite increasingly favorable prognoses for survival of childhood cancer, these patients are at high risk for both acute and late-occurring sequelae associated with their disease and treatments. While all long-term pediatric patients are at high-risk for both late-occurring physiologic and psychosocial effects of cancer therapy, children who receive therapies that impact the central nervous system are at even higher risk for cognitive, social, and psychological disorders (Moore, 2005). Various studies have shown between 40 and 100 percent of survivors of pediatric brain tumors will evidence some sort of cognitive deficit resulting from a combination of disease and treatment variables (see Mulhern & Palmer, 2003, for a review). In addition, at least 30 percent of survivors of blood-based cancers will experience some degree of neurocognitive deficit (Copeland, et al., 1996). The repercussions of these deficits can be lasting and costly, with many childhood cancer survivors never achieving the normal milestones of adulthood, such as living independently, marrying, and procuring stable employment (Maddrey, et al., 2005; Zebrack, et al., 2002, 2004). Hence, some investigators have called for better assessment of critical psychosocial variables associated with a survivor's ability to successfully integrate into society.

Effective social interaction requires focused attention to and interpretation of complex and varied nonverbal social cues including facial expressions, body language, and tone of voice. The largest part of social communication is nonverbal (Knapp, 1972; Mehrabian, 1971), and in particular, facial expressions are one of the richest sources of nonverbal social information (Blair, 2003). Other models (e.g., Crick & Dodge, 1994; Lemerise & Arsenio, 2000) posit that decoding of facial expression represents the first two steps to accurately understand and react to a social situation, and that errors at these levels have potentially negative repercussions for social interactions (e.g., misinterpreting a smile of polite atten-

tion as one of genuine interest). Given that survivors often have nonverbal cognitive deficits (Buono, et al., 1998; Carey, et al., 2001), it is reasonable to assume that they may make more of these types of social errors.

In preliminary studies we used the Diagnostic Analysis of Nonverbal Accuracy – 2 (DANVA2; Nowicki, & Duke, 2001) to assess facial expression recognition in pediatric survivors of brain tumors versus children with Juvenile Rheumatoid Arthritis, and found robustly significant differences between the groups (Bonner, et al., in press). The DANVA2 is a facial recognition task consisting of 48 photographs of adult and child faces, depicting four basic expressions of happiness, sadness, anger, and fear. For each expression, both low- and high-intensity faces are included. Participants are shown each photograph and asked to identify the expression depicted as quickly as possible. While the DANVA2 has shown empirical efficacy for our initial understanding of the apparent complex nonverbal skill deficits in this population, it is an inherently unstandardizable measure that may only tell part of the story. Because the DANVA2 involves actors who were asked to display the appropriate expression after reading a vignette, it is not possible to ensure that the validity or intensity of the facial expressions is standard across photos. Moreover, it is not possible to dynamically adjust the characteristics or expressions of the DANVA2 faces. Thus, errors made by cancer survivors could reflect the actors' failure to accurately display the required expression, particularly for low-intensity emotions which may be harder to represent (especially for child actors).

Facial Emotion Recognition Tools

Recent technological advances have led to the emergence of more sophisticated and innovative methods for assessing children's processing of facial expressions. For example, a study of the effects of maltreatment on children's ability to perceive anger (Pollack & Sinha, 2002) used a computerized method that presents an image starting with an undifferentiated face that gradually gains organization and resolution to form a coherent facial expression. With this innovative technology, researchers found that children with a history of maltreatment recognized anger expressions with less visible information than other children, suggesting that they are sensitized and vigilant to threat cues. Blair and colleagues (2001; Coupland, et al., 2004) have devised the Emotional Expression Multimorph Task that uses images of nine models, each portraying six basic emotions, with expressions manipulated to 40 increments between a neutral state and the full expression. Participants respond as soon as they identify the target emotion during the morph. The tool was capable of yielding deficits in the recognition of facial sadness and disgust in children with psychopathic tendencies, and in establishing links between affect and thresholds for recognizing happy or disgusted faces. Massaro conducted studies using variations of features of a face to assess how children and adults distinguish one face from another (Schwarzer & Massaro, 2001; see also George, Scaife, & Hole, 2000). Massaro has also used a cartoonish face called Baldi within a number of studies involving children (see, e.g., Massaro & Bosseler, 2006). A program called Let's Face It! (Tanaka, et al., 2003) was designed for developing autistic children's face processing skills and normalizing neurological face recognition functions, using pictures of faces and facial components that the child manipulates in several tasks, including recognizing facial expressions and assigning labels to various facial expressions.

However, none of these tools enables the systematic manipulation of an unlimited number of facial expressions, which we feel is important for our research and others' involving social skill assessment. For instance, we were surprised to find no tool using the intensively studied action units that underlie the Facial Action Coding System (FACS; Ekman, Friesen, & Hager, 2002), nor were we able to obtain a tool using non-cartoonish faces that manipulated facial expressions using action units. Thus, we set out to create this tool. The remainder of this paper details the development and addresses system- and user-testing issues surrounding the use of our FER instrument.

Facial Expression Recognition Instrument (FERI): Rationale and Features

We are systematically developing facial expressions by referring to FACS criteria. FACS uses the movement of facial muscle groups (action units; AU's) to measure facial expression. The absence of expert tools that aid in defining the AU's associated with FACS led to an investigation of a similar encoding scheme, the Moving

Pictures Experts Group Facial Animation standard (MPEG-4 FA). Despite the existence of capable tools supporting MPEG-4 FA, their use was limited by subtle differences between the musculature coding of FACS AU's and MPEG-4 Facial Animation Parameters (FAP's). As we were disinclined to devise a complicated mapping between AU's and FAP's, particularly for the child faces that we needed, we followed a more traditional approach of defining AU's using a variety of mesh deformation techniques, rendered as a series of animation keyframes.

The client application is a derivative of Xface (http://xface.itc.it/), an open source project based on the MPEG-4 standard. Modifications to the Xface code and user interface enabled real-time manipulation and blending of dozens of AU's, and caching of the composite of their weighted sum. The initial 3D head known as Alice, the reference model delivered with Xface, was produced using Singular Inversions' FaceGen, the head and face mesh generation application that was already an integral tool in our research product line.

Though FaceGen will output visemes, phonemes, and expressions that we use in other applications (see, e.g., Hubal, Kizakevich, & Furberg, 2007), for this application these files went unused, and instead the head mesh was imported into Autodesk 3ds Max for further manipulation. For each AU, a corresponding vertex selection set was identified and named for later retrieval, though certain AU's representing incongruent muscle groups were composed of the aggregation of multiple selections. AU's mirrored along the vertical axis were divided into independent left and right selections. With the rest mesh at frame zero, animation keyframes were captured, each representing the extreme position of one AU. These deformations were applied to a control mesh, a copy of the original Alice mesh that is mapped against the final 'presentation' mesh, allowing multiple faces to be exported without having to recreate the AU's for each. The Max files are exported as a VRML Flip-book, a native import format of Xface, resulting in one VRML file for every AU.

We chose a subset of AU's to implement, specifically those that are most implicated in facial expression. For example there are a number of AU's associated with the eyes and eyebrows (inner- and outer-eyebrow raising, eyebrow lowering, upper eyelid raising, cheek raising and eyelid compressing, eyelid tightening, all of these for both left and right) that independently or collectively help define different facial expressions. The same is true for AU's around the nose and mouth. The FACS manual describes certain combinations of AU's when those combinations are not necessarily able to be linearly added; for the moment we enable these certain combinations by allowing for the computation of a weighted composite sum.

We are developing an interface surrounding Xface to enable any application designer to define and label those weighted combinations of AU's (actually, the keyframes representing each AU). This interface is important because we do not want our participants to be able to manipulate the AU's individually. Instead, as in some other products, we wish to present to the participant with a single slider bar. The movement of this bar would cause a change between a state signifying a neutral expression and a state (e.g., happiness, disgust) signifying the maximum "intensity" (a FACS term) of a weighted expression.

Evaluation of Feri

In its completed form, the FERI will consist of two basic components. During the first part of the FERI, participants will be shown a series of facial expressions. Within these faces one third will be matched against the participant on race and gender, another third will be matched on race but of the opposite gender, and the last third will be a combination of mismatched races and genders. Additionally, each group will have half high-intensity expressions and half low-intensity expressions. Participants will be asked to identify the presented facial expression, first in an open-choice format and then in a multiple-choice format. Complete verbal responses will be recorded and coded for qualitative information. Children will then be asked to rate their confidence in their response. During the second part of the FERI, participants will be asked to move a slider bar from the starting point of a face's neutral expression to a requested target emotion. Participants will be asked to stop the slider bar once the target emotion is perceived. Similar to Blair, et al. (2001), the point at which the bars are stopped will be quantified.

Before we integrate the instrument into our studies, we will pilot it to evaluate methodology and ease of use with this population, and its validity against the DANVA2. Participants will include both childhood cancer survivors and healthy controls aged 10 to 16. We will verify that children in this age range can understand the task instructions and successfully manipulate the interface (e.g., a slider bar). We also will obtain a range of time that children require to complete the task. Upon completion of the pilot phase, participants will also be asked if they would be interested in returning within three months to retry the instrument; this reassessment will allow for the calculation of test-retest reliability. Finally, we will assure that there is adequate variability in performance (i.e., that the task is neither too difficult nor too easy for children to complete). Based on these data, the instrument's user interface will be revised as needed.

All pilot-testing study procedures involving child participants and a parent will occur during one 90-minute session. Participants will complete a brief assessment of their ability to use the mouse to navigate through task-related procedures (e.g., using a slider bar, clicking on multiple-choice responses) and receive additional assistance or training when needed. Then, their general response time will be measured by presenting a series of faces similar to those that will follow in the actual FERI. Instead of requesting children to identify facial expressions, however, children will be asked to identify the gender of each face depicted as quickly as they can without making mistakes. Additionally, a brief visual acuity task will be administered to verify that participants do not have visual impairments that may prevent them from seeing the faces on the task.

To evaluate the adaptability, feasibility, and initial validity of the FERI, we will analyze descriptive and summary statistics of participant-reported and experimenter observations of ease of use, problems, or complaints. Adaptability of the measure will be assessed in terms of an adequate range of performance accuracy across both subject groups (i.e., survivors and controls), expressions (e.g., neutral, sad, happy), and intensity thresholds (e.g., high, low). We also hypothesize that the digital facial expression recognition task will be valid and reliable for use with childhood cancer survivors and healthy children. For these analyses, we will estimate internal consistency using coefficient alpha, and obtain test-retest reliability using data from participants who have agreed to complete the FERI again after a three-month interval. We will assess convergent validity by correlating scores from the forced-choice portions of the instrument with the child faces subtest of the DANVA2. Finally, we hypothesize that errors on the facial expression recognition task will be associated with increased impairment on parent and self-reported measures of social functioning and quality of life. We will look at total errors on the FERI as a predictor of social functioning outcomes in a series of regression analyses.

Limitations and future direction

We see this work as extending to other clinical areas. For instance, we plan to extend our investigation of facial expression of emotion to include broader non-verbal cues, such as body posture or head and hand gestures, all easy to implement with precision with well-understood modifications to the tool. Such an extension would allow researchers to gain a clearer and more complete picture of the deficits faced by childhood cancer survivors and would lead the way towards development of interventions to ameliorate some of these deficits and improved quality of life. Similarly, if expected deficits are found during hypothesis testing (e.g., survivors make significantly more errors in facial recognition than healthy controls; survivors have a higher threshold for perceiving negatively-valenced emotions than healthy controls), then the tool could be used to create a social functioning intervention. One intervention idea would be to create semi-transparent "overlay" templates to train childhood cancer survivors to pay attention to specific, salient features of facial expression. Such a task would allow survivors to become both more efficient and more accurate in their facial expression recognition. Additionally, the tool would allow for the creation of virtual and interactive social scenarios (see Paschall, et al., 2005; Hubal, et al., 2008) that would allow for tutored training and exposure to typical social scenarios that could be practiced until the child is both adept and confident in his/her actions. This tool extension would be relevant for other clinical populations as well, for instance as a training tool for social functioning used by people with autistic spectrum disorders.

Acknowledgements

The work described here was performed under award 1-R03-CA-128472-01 from the National Cancer Institute (NCI). Preparation of this paper was partly supported under award IIS-0534211 from the National Science Foundation (NSF). Points of view in this document are those of the authors, and do not necessarily represent the official position of NCI or NSF.

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Supporting low ability readers with interactive augmented reality

Andreas Dünser

The HIT Lab NZ, University of Canterbury, Christchurch, New Zealand

andreas.duenser@hitlabnz.org

Abstract: *Augmented Reality (AR) is a technology which allows the overlay of 3D virtual images onto the real world, and which has been used to develop various educational applications. By actively involving the learner, AR offers interesting possibilities for creating engaging educational media. To study how interactive AR affects different kinds of learners we used an AR based storybook designed for early literacy education. We found that good readers re-told significantly more events from text passages than low ability readers. However, for the AR interactive sequences, there was no difference between the two groups in retell and recall performance. These results indicate that AR books that allow children to interactively engage with the content may be a good learning medium to support low ability readers.*

Introduction

Augmented Reality (AR) allows the user to view and interact with virtual content in a real environment. Computer generated content is embedded into the real world and registered in 3D space. This technology has been used to develop various kinds of educational applications many of which were realized as augmented books. The notion of augmenting a traditional medium with virtual content was introduced with the MagicBook (Billinghurst, Kato, & Poupyrev, 2001). This is an AR book containing 3D virtual and animated content registered on real pages, mimicking a traditional “pop-up” book. Augmented books combine the advantages of physical books with new interaction possibilities offered by digital media.

Books can be enhanced with interactive visualizations, animations, 3D graphics and simulations (Shelton, 2002). Various implementations of the MagicBook paradigm range from computerized “pop-up books” that allow the user to see animated 3D content and associated sound (e.g. the eyeMagic book (McKenzie & Darnell, 2004) and books that allow users to interact with the virtual content (e. g. the AR Volcano (Woods et al., 2004), to books in which the user can seamlessly move inside the book, being fully immersed in a virtual environment (Billinghurst et al., 2001). These books and the possibilities they offer have caught the attention of researchers who are interested in studying their use in education and potential benefits they offer in this area.

Figure 1. *Examples of MagicBook implementations; left: ARVolcano (Woods et al., 2004); right: eyeMagicBook (McKenzie & Darnell, 2004)*

Learning with interactive augmented reality books

Learning and comprehension can be supported by interaction, self directed learning, exploration and collaboration (Mantovani, 2001) . According to Loftin et al. (1993), educators generally agree that experience is the best teacher. However, in reality students are seldom given the opportunity for direct experience of what is to be learned. To a certain extent this could be due to the media that are used in traditional educational.

One advantage of using novel technologies is that they may engage students to work and learn with new these new learning materials (Byrne, Holland, Moffit, Hodas, & Thomas A. Furness, 1994). Regian et al. (1992) argue that if learning can be made more interesting and fun, students may remain engaged for longer periods of time. Incorporating new media in education can augment the reading and learning experience (Loftin et al., 1993), motivating learners and enhancing engagement. There may be unique benefits to having students experientially engaged in the learning context. According to Roussos et al. (1999) there is reason to believe that the ability of Virtual Reality (VR) to situate users in an alternative cognitive frame of reference may be the most valuable contribution to learning. Winn et al. (2002) found that immersion in a virtual environment can help students construct understanding of dynamic three-dimensional processes.

Ucelli 2005 et al. (2005) argue that we can build up knowledge by interacting with others and with materials in an environment that stimulates the learners personal learning style. We learn better when educational content is presented to us through different means and through different channels. Traditional educational methods, which rely on textbook and basic practical lessons, have certain limitations in supporting learners to develop understanding and their intellectual skills (Chen, 2006), and limitations in supporting learners with different cognitive abilities and different learning styles. Students learn through a variety of different mechanisms, many of which are not provided in traditional educational methods (Bell & Fogler, 1995).

Interactive AR can overcome some of these limitations by providing innovative presentation and interaction capabilities, and concrete experience and active experimentation. Integrating text, audio, 2D illustrations, 3D virtual content, and animation allows students to learn according to their preferred learning style. New methods and media cannot only add various educational delivery mechanisms, but “specifically address those areas where traditional methods are weakest” (Bell & Fogler, 1995, p.3).

AR enables the user to experience the real world augmented with computer generated content, and facilitates intuitive interaction with virtual content in real time. Interactive AR can provide a better understanding of complex content that can be actively manipulated and explored (Dünser, Kaufmann, Steinbügl, & Glück, 2006). The physical aspects of an augmented book enable quite intuitive and easy to use interaction methods. For example, different virtual scenes can be introduced by simply turning the book pages, or additional tangible elements can provide other ways to interact with and actively manipulate story elements (Kato, Billinghurst, Poupyrev, Imamoto, & Tachibana, 2000). Tangible interaction can provide innovative ways for children to play and learn, bring playfulness back into learning and support collaborative learning (O’Malley & Fraser, 2005; Price, Rogers, Scaife, Stanton, & Neale, 2003; Tallyn, Frohlich, Linektscher, Signer, & Adams, 2005).

Interactive augmented books do not solely rely on text and static 2D illustrations, so these learning environments could be valuable for learners who have problems with traditional text based materials such as students with low reading skills or dyslexic students. However, there is little known about the effectiveness of augmented books as instructional tools (Shelton, 2002). In our research we have been investigating how young children interact with augmented books and the tangible interaction devices, and how the design of the system, the interactive sequences, and the story impact on interactive behavior (Dünser & Hornecker, 2007a2007b).

In this paper we provide a first investigation of how an interactive AR book that conveys information through multiple channels may support learners with different reading abilities. We examine what good readers and low ability readers are able to remember after interacting with an interactive AR story book.

In the remainder of this paper we first present the system and story book we used for this experi-

ment and then discuss our findings and their implications. Finally we present our conclusions and discuss directions for future work.

Study

The AR system and story books.
We used a desktop based AR system with a web camera mounted on top of a computer screen which showed the augmented view. The AR story book consists of paper pages and cardboard paddles containing black square ARToolKit markers (Kato & Billinghurst, 1999).

Once the markers are within camera view the augmented book content becomes visible on the screen (overlaid onto the markers). This setup allows the user to see real and virtual content in a combined view in front of them as well as themselves interacting with the story (see Figure 2). An advantage of this setup is that it can be used on standard computer equipment. Hence it can be used in most modern classrooms or homes without requiring expensive additional hardware. However, it does not provide an integrated view of real and virtual objects like other AR setups using head mounted displays.

The book we use is “Big Feet and Little Feet” which tells the story of two little baby chickens who have been left behind and have to overcome several obstacles to find their mother. This story and other AR books have been created by the BBC for their AR-Jam project and are aimed at early literacy education (Dünser & Hornecker, 2007a2007b; Smith et al., 2007). The story-book consists of text pages and AR sequences. The text pages are shown on the computer screen and the children use the mouse for interaction (next page, back, close page). By clicking on a listen button the text is read to the children.

Figure 2. *left: book page and paddles with ARToolKit markers; middle: setup of our system: the camera on-top of the computer screen tracks the markers and the screen shows the augmented view; right: example of augmented view.*

In the interactive AR sequences the paddles (and paper pages) are used for interaction. The children have to solve different interactive tasks in the AR sequences. Each interactive sequence is represented on a separate book page. Therefore the children have to turn the paper pages before starting with a sequence The pages usually have 'hot spots' next to the markers, indicated by a grey outline or other drawings. Placing paddles on a hot spot usually triggers certain events. For example, in one task the chickens have to sneak past the sleeping fox without waking him up. For this the children have to move their paddles (augmented with 3D models of a chicken) along a certain path from the start to the finish sign. If the chicken come too close to the fox he wakes up, growling, and the children have to start again (see Figure 3).

Participants

Twenty-one six and seven year olds (10 male, 11 female) from two primary schools read and interacted with the AR book.

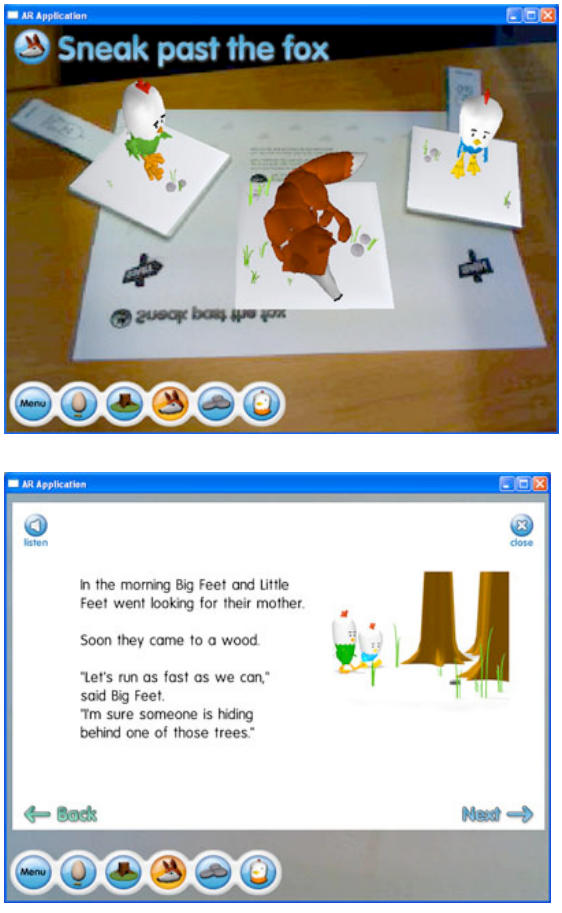

Figure 3 *Example for interactive screen (top) and text page (bottom).*

The study was conducted at a Library and Learning Centre that collaborates with local schools and offers various literacy programs. The participants were recruited from two nearby schools. The children were chosen by their teachers according to their reading skills. One group of nine children was identified by their teacher as being good and avid readers. For the other group, twelve children with low reading skills were chosen who were less curious about or interested in books. Most children from this school lived in a socioeconomic neighborhood with lower income levels.

Method

All children read and interacted with the book in a controlled experimental setting either in pairs (9 pairs) or individually (3 children). The experimental sessions lasted for approximately 40 minutes. Two researchers were present during the sessions to support the children if problems arose or they got stuck with the story. With some initial help, most children were able to interact with the system without much prompting.

After the children finished the story-book they were interviewed individually. The child's ability to recall and retell the story was scored using a list of story events. Retell performance was scored as the number of events correctly retold by the children without any hints. If, after the children finished retelling the story, some events were not retold the interviewer gave some hints (e.g. "What happened after…?"). Recall was scored as the overall number of events recalled. We were interested in studying which children could retell or recall more events from either the text parts or interactive sequences. Hence we scored eight events that were mentioned in the text parts and another six events that related to interactive sequences.

For completion time analysis we measured times spent for text passages and times spent for interactive sequences. In a final semi-structured interview we asked the children several questions such as 'What did you like best?' or 'Would you like other books like this?'.

Results

Figure 4 shows the average recall and retell scores for the text and interactive sequences, from both the good readers and the low ability readers.

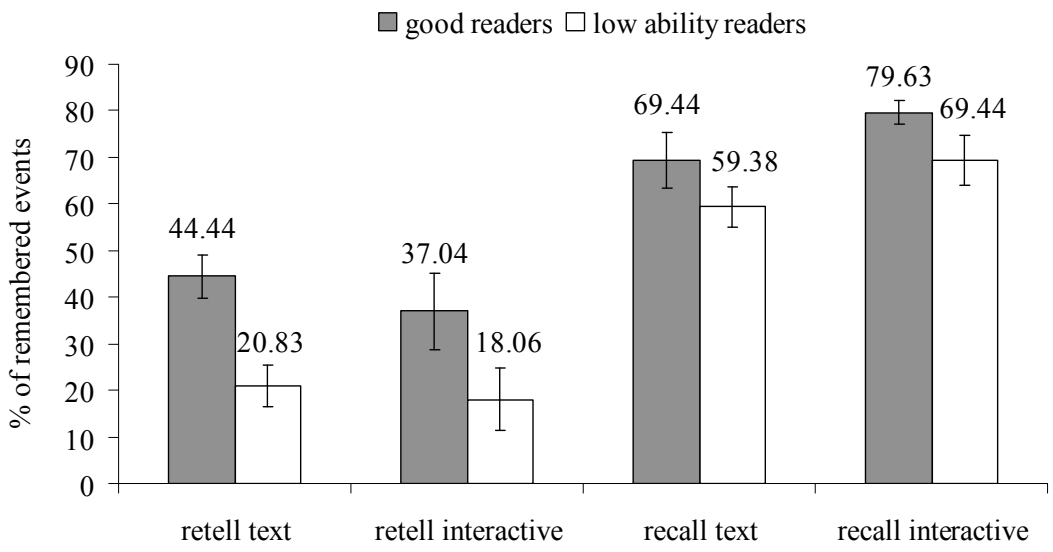

Figure 4. *Scores for retelling and recalling story events form text passages and interactive sequences (error bars M+/- 1 SE).*

We found that the good readers retold significantly more events from text passages (t (19) = 3.36, p < .01) compared to low ability readers. Good readers retold on average 44.44 % (*SD* = 14.13) of events, whereas low ability readers only retold 20.83 % (*SD* = 17.13) (see Figure 4). However, there were no significant differences in retell performance of interactive sequence events between the two groups. Thus good readers remembered significantly more events from text passages than low ability readers but not significantly more events from interactive sequences. No significant differences could be found for recall performances. Therefore, with some hints from the experimenters, the two groups scored similarly for both the text and interactive sequences.

The analysis of completion times showed that good readers finished significantly faster with both the text passages (t (19) = -3.37, p < .01) and the interactive sequences (t (19) = -2.94, p = .01). Good readers spent on average 6.85 minutes (*SD* = 1.60) with text passages and 8.42 (*SD* = 4.50) with interactive sequences, for low ability readers these times were 8.84 (*SD* = 1.11) and 12.89 (*SD* = 2.42) respectively. Overall the time spent with the augmented books was on average six and a half minutes longer for low ability readers. They interacted with the book approximately four and a half minutes longer and spent around two minutes longer with the text passages. As most children choose to listen to the story, and thus listened to the same prerecorded voice, the time differences for text passages are smaller. Although both groups were able to interact with the stories on their own after some initial scaffolding, low ability readers tended to get stuck more often and needed a little bit more support which explains the longer interaction times.

Analyzing the children's interview answers we found no systematic differences between the two groups. When asked what they liked best, almost all children referred to events of interactive sequences with 'cracking the eggs' (the first sequence where the children had to bang their paddles to crack virtual eggs) being the most favourite. Two children mentioned that they liked using the paddles.

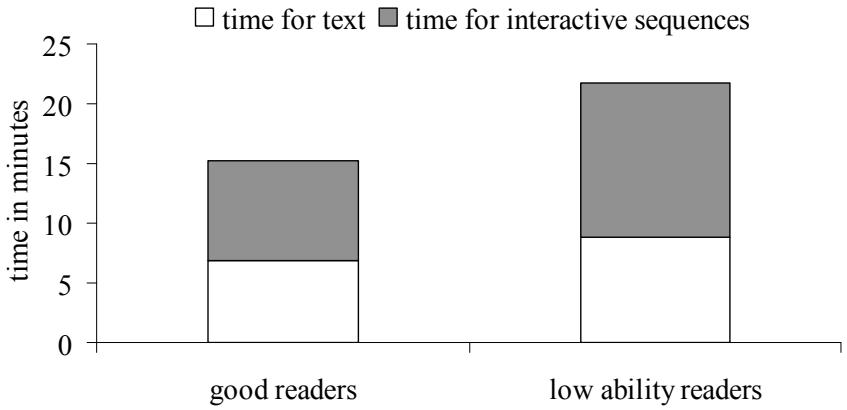

Figure 5. ***Times the good and low ability readers spent for text passages and interactive sequences***

When asked if they would 'like other books like this', four of the low ability readers answered with no, while all good readers answered yes. This might be because we asked if they liked other 'books' like this. Most children referred to the AR book as a 'computer game' rather than a 'book'. In future studies we might have to rephrase this question to see if this is based on misunderstanding or if we can find a tendency that low ability readers are in fact less keen about such books.

Discussion

In this pilot study we found that the good readers retold significantly more events from text passages than the low ability readers. However, for the AR interactive sequences, there was no significant difference between the two groups. These results give a first indication that interactive AR books may be a means to help low ability readers to perform on similar levels as good readers in terms of being able to retell information. In further studies we plan to study this with bigger sample sizes and more rigorous testing methods.

Our study suggest that AR educational media could be a valuable and engaging addition to the predominantly text based materials that are used in schools today. Chen (Chen, 2006) argues that the current textbook based methods pose various limitations in assisting learners in recalling knowledge. Interactive AR allows designers of educational materials to integrate different media and delivery mechanisms, and allows students to take in knowledge according to their preferred learning style. While conveying information through different channels can be helpful especially for learners with certain difficulties, we all can benefit from multisensory learning (Bell & Fogler, 1995).

Apart form just presenting knowledge, augmented books enable readers to interact with the content. Therefore learners not only passively take in information but actively engage with the content. Being able to interact with the story seems to be an important factor for engagement and might also facilitate retention of story events. Winn (Winn, 2003) for example found that bodily activity in virtual environments can support enhanced understanding. Further indication of how interacting with virtual environments can engage students is given by Byrne et al. (1994), who report that at "risk students" showed up to class more often and with more enthusiasm during a program where they could create their own virtual world. However, we cannot preclude that some of this engagement caused by experiencing and interacting with these technologies is due to a novelty effect. This issue should be addressed in future longitudinal studies.

Children in our study enjoyed interacting with the augmented books and 'moving around' the paddles. They referred to the books as games, some asked how it worked, and one child even said "It's magic". When asked what they liked best the story remained dominant in their subjective experience. In earlier research (Dünser & Hornecker, 2007b) we discussed how story design and the design of interactive sequences influence engagement and enjoyment of the overall experience.

Conclusion

We presented a study to investigate how interactive AR books can support children with different reading abilities. We found that these can be very engaging educational media that can overcome some of the limitations of predominantly text based materials. By addressing multiple learning modalities and offering interaction with the content AR books can support students who have problems with traditional textbooks.
In future work we want to study the exact mechanism how interactive AR can influence learning. We have to better understand the benefits that such novel learning media have for education.

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Initial results from the ViRTICo trial: virtual reality therapy and imaging in combat veterans

Michael J. Roy, MD, MPH; Jennifer Francis, PhD*; Joshua Friedlander, PhD*; Lisa Banks-Williams, MSN, APRN*; Raymond G. Lande, DO*; Patricia Taylor*; James Blair, PhD#; Meena Vythlingam, MD#; Jennifer McLellan, MS, RN#; Wendy Law, PhD*; Ivy Patt, PhD; Joann Difede, PhD@; Albert Rizzo, PhD^; Barbara Rothbaum, PhD$.*

**Uniformed Services University, Bethesda, MD, and Walter Reed Army Medical Center, Washington, DC.*
#National Institute of Mental Health, National Institutes of Health, Bethesda, MD.
@Weill Medical College of Cornell University, New York, NY.
^Institute for Creative Technologies, University of Southern California, Los Angeles, CA.
$Emory University School of Medicine, Atlanta, GA.

Abstract: Many wars have a signature illness—or two—for which they are remembered, such as "Soldier's Heart" after the American Civil War or Shell Shock and mustard gas injuries after World War I. Vietnam introduced posttraumatic stress disorder (PTSD) to our lexicon, and Desert Storm wrought "Gulf War Syndrome". War also spawns innovative medical responses that in turn spur significant medical advances with society-wide benefits. The American War of Independence introduced litters for carrying wounded soldiers, Napoleon's forces added specific litter-bearing teams, and the American Civil War saw the advent of horse-drawn "ambulances". World War II fostered burgeoning medical specialization, a trend that continues today. Amputations are one face of Operation Iraqi Freedom, because body armor protects the torso, while rapid response medical and surgical care and superb air transport casualty care greatly improve survival following severe limb injuries. This is driving major advances in wound care and prosthetics. In addition, the nature of the conflict in Iraq, with suicide bombers, improvised explosive devices (IEDs), and no clear battle lines or safe zones, is responsible for high rates of both PTSD and traumatic brain injury (TBI). This provides an opportunity to improve the diagnosis and treatment of PTSD and TBI and we hope the work we describe here will contribute to that discussion.

PTSD has been identified in 10-20% of veterans of recent wars. However, diagnosis relies on self-report, and multiple factors lead some to under-report symptoms while others over-endorse. The best-validated instrument, the 17-page Clinician-Administered PTSD Scale (CAPS), takes a trained professional (usually a psychologist, often in short supply) an hour to administer[1]. Self-administered alternatives such as the 17-item PTSD Checklist (PCL) lack the accuracy of the CAPS. Since PTSD is associated with poorer physical and mental health, functional impairment in multiple domains, and higher healthcare costs[2-4], validation of an objective diagnostic tool could reduce stigma, enable more expeditious treatment and direct compensation appropriately. An imaging technique such as functional magnetic resonance imaging (fMRI), while not inexpensive, might still be cost-effective compared to hiring and training psychologists to administer the CAPS.

The diagnosis of TBI is straight-forward with unequivocal loss of consciousness, but obstacles to making an objective diagnosis of mild TBI are even greater than for PTSD. There are no standardized criteria for diagnosing mild TBI in the absence of loss of consciousness; proposed criteria include immediate reactions such as feeling dazed or confused, or not remembering the injury, and later symptoms including memory or concentration problems, irritability, sleep difficulties, and headaches. The initial reactions are hard to establish a threshold for, as surprise and confusion are nearly universal in an unexpected explosion. The later symptoms are non-specific, and frequently reported with PTSD and depression, so it is no surprise that extensive overlap has been reported between mild TBI and PTSD[5]. In this study, we use "blast exposure" as a surrogate for mild TBI, yet even this has ambiguity.

Functional MRI is a potent, novel method which might objectively assess the impact of trauma on the central nervous system, by measuring oxygenation, most influenced by blood flow, to key areas of the brain. Patients with PTSD exposed to various stimuli have been shown to have greater activation in the amygdala, with lesser activation in the anterior cingulate gyrus, than controls[6-8]. Our study utilizes the Affective Stroop—which has shown efficacy in distinguishing those with PTSD from trauma-exposed controls [9-10]—as well as a novel stimulus (virtual reality) we hope will prove superior at sorting out PTSD and TBI in OIF/OEF veterans.

Improved identification of PTSD and TBI is a key first step, but more effective treatment is also imperative. Successful treatment of PTSD should improve quality of life and functional status, decrease symptom severity, and reduce vulnerability to subsequent stress. A recent Institute of Medicine report concluded that cognitive behavioral therapy (CBT) with exposure therapy is the only therapy with sufficient evidence to recommend it[11]. Imaginal exposure is the most widely employed exposure method, requiring the patient to repeatedly recount their traumatic experience to their therapist in progressively greater detail. However, avoidance of trauma reminders is a defining feature of PTSD, so many patients have difficulty with this, establishing a need for another method to engage patients in order to expand the application and efficacy of exposure therapy. Virtual reality (VR) has significant promise in this regard; the treatment phase of our study is therefore designed to establish that the efficacy of VR exposure therapy (VRET) is comparable to that of Prolonged Exposure (PE), the best-evidenced form of imaginal exposure.

Methods

Baseline Assessment
After informed consent is obtained, the initial assessment includes:

- Self-administration of PCL-M, Beck Depression Inventory-II, Beck Anxiety Inventory, CAGE, and AUDIT to assess for PTSD and comorbid conditions
- Self-administration of the SF-36 and WHO-DAS-II to assess functional status
- Administration of the CAPS and Structured Clinical Interview for DSM-IV (SCID) by a mental health professional, blinded to the treatment assignment of the subject, to document severity of PTSD and to diagnose comorbid mental disorders
- A medical history and physical examination by the principal investigator (MJR), an internist

Imaging phase
Four groups of 22 OIF veterans (total of 88) each will be included: 1) Blast exposed with PTSD; 2) Blast exposed without PTSD; 3) PTSD without blast exposure; 4) Neither PTSD nor blast exposure. Functional MRI is performed on all 4 groups of veterans, utilizing both the Affective Stroop test and digital photographs taken by U.S. service members deployed to Iraq and Afghanistan. The photographs include 30 emotionally charged (e.g., terrorists holding rocket launchers, corpses, burning vehicles) and 30 neutral pictures (landscapes, sunsets, buildings) taken by deployed U.S. service members in Iraq and Afghanistan, displayed in random order for several seconds each, separated by a neutral background. The images were selected from hundreds of photographs based on pooled ratings for emotional stimulation and neutrality, respectively, by OIF/OEF veterans and their physicians and psychologists.

Treatment phase
The 44 fMRI Phase participants with PTSD (half of whom also have blast exposure) separately consent to randomization to either VRET or PE in twelve ninety-minute sessions spread over approximately 6 weeks. Any imaging phase participants who decline randomization will be replaced by additional recruits. PE has been described[12]; our approach is adapted from a study manual developed by Foa and colleagues. For both the PE and VRET arms, the first 3 sessions focus more on cognitive behavioral techniques, as well as preparation for exposure therapy which begins in the 1st session for PE and the 4th session for VRET. For VRET, the initial exposure is deliberately less approximate to the individual's trauma, while subsequent sessions more closely approximate it. The final session helps the participant look forward, and does not include VR. The Virtual Iraq environment was developed by the Institute of Creative Technologies at the University of Southern California, and has been described[13].

The subject views visual displays on an Emagin Z800 3DHead Mounted Display (HMD) with tracking; noise-canceling stereo ear phones provide sound. The HMDs are light-weight with high-resolution color displays (600 by 800 pixels, 40 degrees of field view), providing a relatively natural experience for the wearer. The therapist monitors what the participant sees on one computer screen, introduces various sensory stimuli through a second, and monitors physiologic responses with a third. The participant sits or stands on a motion platform that provides tactile sensations such as an explosion or moving vehicle. A smell machine provides olfactory sensations such as chordite, Middle Eastern spices, burning rubber, and body odor. The subject controls the pace and direction of movement through the virtual environment with a game-type controller; an alternate controller mounted on an authentic rubberized replica of an M-16 rifle provides an even more realistic sensation in ambulatory environments.

After completion of treatment, fMRI is repeated to assess for treatment-induced changes. In addition, clinician-administered instruments are repeated at the end of the treatment phase and at the end of a 12-week follow-up phase, while self-administered questionnaires are completed at 2-week intervals throughout treatment, and at 4-week intervals during follow-up.

Inclusion and Exclusion Criteria

In order to participate in the study, individuals must have been deployed to Iraq or Afghanistan; be able to give written informed consent; and be in good physical health. In addition, specific criteria for each subcategory are: 1)Those with PTSD must have a CAPS score of 40 or more; 2) Blast exposure requires having been in the immediate vicinity of an explosion, close enough to have felt the impact, ranging from as little as forceful air, up to direct impact with bodily injury and/or transient (<2minutes) loss of consciousness; 3) Non-PTSD, non-blast exposed controls must have been deployed to Iraq or Afghanistan for at least 3 months, must never have been treated for PTSD, and must have a PCL-M score less than 35. Those without blast injury must never have had a concussion or trauma-related loss of consciousness, including in a motor vehicle accident or in sports or recreational activities.

Individuals are excluded for dementia or inability to understand written and oral questions for any reason; a clinically significant or unstable medical disorder (e.g., unstable angina, or uncontrolled diabetes mellitus or hypertension); meeting DSM-IV criteria for alcohol or substance abuse or dependence within 1 month prior to screening; high risk for homicide or suicide; a history of schizophrenia, schizoaffective disorder, or bipolar disorder. Participation in the imaging phase is prohibited for those with shrapnel fragments or any other metal within the body that would pose risks with the use of MRI. A history of claustrophobia or inability to tolerate a prior MRI without sedation is also exclusionary, as sedating medicine could interfere with fMRI interpretation.

Results

To date, a total of 13 veterans have consented to participate in the study, though three voluntarily withdrew from the study prior to the baseline fMRI scan, and another was ineligible due to sub-threshold PTSD symptoms that prevented categorization as either a PTSD case or control. Seven completed the baseline scan (two of whom have also completed their posttreatment scan), while two await the scan. The numbers thus far are too small to permit analyses of fMRI data, but the scans have been well tolerated.

Of the seven participants to complete the imaging phase of the study, two were healthy controls, while the other five all progressed to the treatment phase. Three were randomized to VR, and two to PE. One participant in the PE arm withdrew after 7 treatment sessions due to difficulty performing at work while engaged in treatment; the other four all completed treatment.

The PCL scores reported by participants appear in Figure 1. Subjects A, C, and D received VRET, whereas B and E received PE. The numbers are insufficient for statistical analyses, but modest improvement in self-reported scores is evident; subjects have also reported decreased avoidant behavior to their study therapists such as using the subway and attending restaurants, sporting events, and movie theaters.

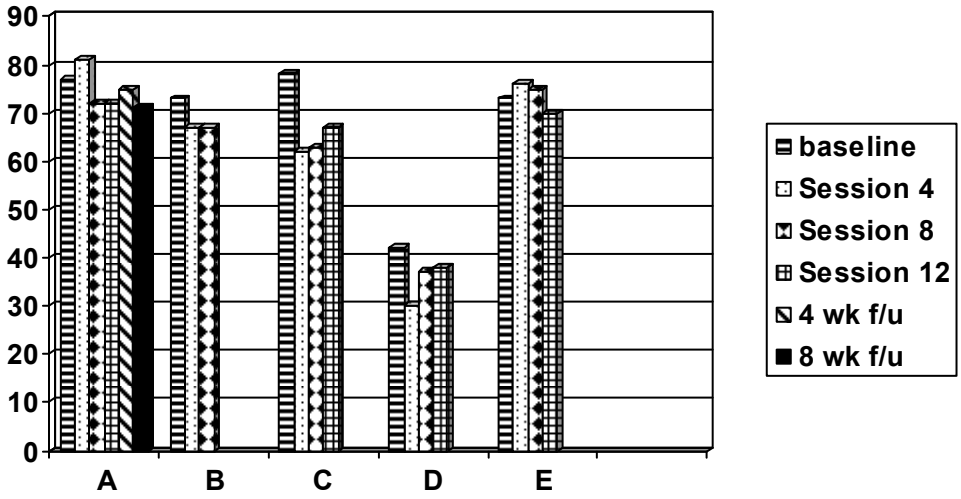

Figure 1: PCL Scores for first 5 subjects in treatment phase

Discussion

A recent report documents the difficulty distinguishing mild TBI from PTSD[7]. The Affective Stroop test, like other psychological tests, has been shown to differentiate individuals with PTSD from controls. However, it is unclear to what degree blast exposure, a surrogate for mild TBI, might modulate such differences. Images, such as "Whalen faces", which include a series of both happy and fearful faces, have been shown to elicit differences between those with and without PTSD, and we hypothesize that our photographs from Iraq and Afghanistan will prove particularly powerful in differentiating veterans with blast exposure and/or PTSD. As additional participants complete the study, we hope to soon be able to ascertain whether this is indeed the case.

In recent years, VR technology has been utilized to help patients overcome various phobias[14-18], social phobia[19], anxiety disorders[20-21] and PTSD. In the latter case, Rothbaum and Hodges found modest efficacy with VRET for Vietnam War veterans, despite the passage of 20-30 years since their trauma[22]. Even with the absence of avatars, their "Virtual Vietnam" environment achieved high "presence" with participants, manifest by participants reporting seeing things like the enemy and burning vehicles that were in fact part of their own memories rather than the virtual environment. More recently, Difede et al. demonstrated impressive improvements in World Trade Center workers treated with CBT/VRET compared to waitlist controls[23]. It is notable that those participants in this trial had previously failed or refused imaginal exposure. This virtual environment included avatars, but like Virtual Vietnam, also utilized a pre-determined sequence, regardless of the actual traumatic experience of the individual.

Among the advantages of the "Virtual Iraq" environment employed here is the ability to individualize the experience through: a range of user perspectives including urban streets, building interiors, and inside a "HUMVEE" in a convoy or at a checkpoint; insertion in the environment alone, with a buddy, or with a patrol; tailored introduction of intermittent or persistent machine gun fire, mortars, or rocket-propelled grenades, as well as friendly or enemy soldiers, civilians, and air and land vehicles; choice of time of day from dawn to mid-day to dusk, and even night via the green perspective of night-vision goggles. Continuous physiologic monitoring of skin impedance (a measure of diaphoresis), respiratory rate, heart rate, and blood pressure supplements the participant's subjective units of discomfort (SUDs score) to enable further individualization of the pace and direction of therapy. The realism of the visual environment exceeds previous programs, reflecting both technological advances as well as the evolution of this environment from an X-box game. Finally, stimulation of 4 different senses heightens the potential impact of the VR environment. Preliminarily, one case report documents a 56% decrease in the CAPS score of an OIF vet-

eran with 4 sessions of VRET using Virtual Iraq. In summary, it is reasonable to anticipate, but remains to be proven, that the individualization and high quality of this virtual environment may increase the efficacy of exposure therapy.

Many treatment trials of PTSD involve comparison to placebos, waitlist controls, or usual care. Since proven therapies exist, the ethics of this approach could be questioned; while an active control mandates larger numbers, it still seems more judicious. Direct comparison of VRET to PE also provides the opportunity to assess whether VRET might engender a more rapid response than PE, by triggering more memories and feelings for patient and therapist to work through.

Coupling imaging and therapy together in a single study makes the study a bit more cumbersome, but may pay significant dividends. First, conduct of fMRI pre- and post-treatment enables us to measure changes with therapy, and whether those changes correspond with self report. Second, fMRI may demonstrate patterns that could identify who are more likely to respond to one form of treatment than another, facilitating targeted therapy which should improve response rates. If we see such patterns, future research would be necessary to corroborate that targeted approaches can indeed improve overall response rates. While comparisons with active therapies, including the best currently available, makes it more difficult to demonstrate the superiority of our novel treatment (the primary reason for selecting a non-inferiority design for this study, due to the prohibitively large sample size required to demonstrate superiority), we believe that such comparisons are necessary in order to persuade providers and patients to adopt this novel therapeutic modality, and that our virtual environment has considerable strengths which make such comparisons feasible. The ability to individualize the exposure, progressing from relatively innocuous stimuli to highly charged stimuli for each patient, as well as the range of sensations (visual, auditory, tactile, and olfactory) and settings (inside and outside buildings, vehicles, etc.) are especially salient in this regard. As a result, we believe that “Virtual Iraq” will prove more acceptable than other exposure therapy approaches, will accelerate the rate of improvement in PTSD symptoms, and will result in a higher rate of response.

The identification of individuals with mild TBI, represented by blast exposure, has the potential to be a significant element of this study as well. Several studies are underway to examine moderate to severe TBI in OIF/OEF veterans, but the mild end of the spectrum remains an enigma. Prior PTSD treatment trials appear to indicate that combat veterans have lower response rates than civilians, yet the reason for this remains unclear. Perhaps it is due to the relatively horrific or prolonged exposures that combat veterans are subject to, but it is plausible that it may be the result of comorbid mild TBI, which our study design gives us the ability to address.

There are some potential limitations to our study. Most notably, we must rely largely on self report to determine which participants have PTSD and/or TBI start of the study. We have already seen that discrimination of TBI can be difficult. Trying to get a definitive answer regarding how close one was to a blast, whether the pressure wave knocked them to the ground or they went to ground voluntarily to protect themselves, to what degree and for how long they were dazed and confused, has proven notoriously difficult. Hopefully, we will find that fMRI clearly discriminates between TBI, PTSD, and the combination, making it a particularly useful modality.

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Effects of different virtual reality environments on experimental pain rating in post-stroke individuals with and without pain in comparison to pain free healthy individuals

Shahnaz Shahrbanian[1], M.A., Maureen J. Simmonds[1], Ph.D., PT

1. School of Physical & Occupational Therapy, Faculty of Medicine, McGill University, Montreal, CANADA

shahnaz.shahrbanian@mail.mcgill.ca

Abstract: *Virtual reality (VR) is a computer-based, interactive multisensory simulation that occurs in real-time and has been used for pain reduction. The effectiveness of VR in reducing acute procedural pain has been established however the effectiveness of VR for chronic pain has not been tested. In addition, it is not clear whether different VR environments have a differential effect. The objective of this study was to determine whether different virtual environments (VE) had a differential effect on experimental pain rating in stroke patients with moderate to severe persistent clinical pain. Thirty six subjects participated in this study: twelve stroke patients without pain, twelve stroke patients with pain in their upper limb, and twelve pain free control participants. Quantitative sensory testing (QST) was conducted using the method of limits standard test protocol. Thermal stimuli were applied to subjects' forearms within the range of weak to strong intensities to assess pain ratings of hot and cold stimuli while subjects were immersed in a virtual reality environment viewed through a head-mounted display. The VEs were randomly presented and were: cold (Snow World), Hot (Dante's Canyon World), Neutral (black and white pillars), and No VR (control condition). After each thermal stimulus, subjects rated their pain perception on the basis of 0-100 scale of intensity. The mean pain ratings for hot and cold stimuli were calculated and used for analysis. Preliminary analysis of results showed that for patients in the stroke group with pain, Dante's canyon (hot VE) decreased pain rating to both hot and cold stimuli ($p<.05$), but other VE environments had no effect. For patients with stroke but with no pain, neutral environment decreased pain ratings to both hot and cold stimuli ($p<.05$). Virtual reality environments differentially influence experimental pain ratings in patients with stroke, depending on the presence or absence of clinical pain.*

Stroke is an injury to the brain due to the interruption of the blood supply, which causes destruction of a portion of brain tissue that can lead to weakness, numbness, paralysis, or cognitive problems. According to the World Health Organization 15 million people around the world suffer a stroke each year, with five million of those episodes resulting in death and a further five million people left with a permanent disability. In the U.S there are more than 5 million stroke survivors, and each year about 780,000 Americans suffer a new or recurrent stroke (The Stroke Association, 2008). The majority of people affected are over 65. Stroke is a leading cause of adult disability in the United States and Europe (*Feigin, 2005).* According to the American stroke association, Americans will pay about $65.5 billion in 2008 for stroke-related medical costs and disability.
Pain is a common problem after stroke such that more than 20% of stroke patients have persistent moderate to severe pain (Jonsson, 2006) and about 8% will have central post-stroke pain (Canadian Stroke Network, 2006). The onset of pain may occur at the time of the stroke but often occurs several months later. The precise cause of central post-stroke pain is unknown, but most frequently pain occurs in a part of the body affected by the stroke often in the arm and leg on the stroke side. Movement, changes in temperature, or other unrelated stimuli may intensify the symptoms. Although many treatments are available for pain reduction, a survey conducted by the American Pain Society in 1999 found that more than four out of ten people suffering moderate to severe pain were unable to find adequate pain relief. Untreated chronic pain has a negative effect on an individual's quality of life, decreasing the ability to concentrate, and work, often leading to depression, and loss of self esteem.

Virtual reality (VR) is a computer-based, interactive multisensory simulation that occurs in real-time and has been used for pain reduction (Weiss, 2006). It is believed that VR can provide a means of attracting attention to a specific virtual environment or alternatively distracting attention from a painful experience. In a series of preliminary studies, Hoffman, has shown that patients with severe burns using VR have reported large reductions in worst pain, pain unpleasantness, and time spent thinking about procedural pain (Hoffman, 2000, 2001a, 2004d) and report having more fun and less anxiety during various painful procedures. VR has also been used in different clinical settings to reduce dental pain (Hoffman, 2001b), prostate thermo-surgery (Wright, 2005), cancer pain (Gershon, 2004), and symptoms from cancer chemotherapy (Schneider, 2004). The effectiveness of VR for chronic pain has not been tested.

The use of immersive VR for post stroke pain has not been previously tested. In addition, it is not clear whether different VEs have a differential effect on pain ratings. This is an important question given that pain is known to be aggravated by heat and cold in (real) environments. The objective of this study was to determine whether different VEs have a differential effect on pain ratings in stroke patients with and without post-stroke (clinical) pain. We hypothesized that all virtual environments would reduce pain perception compared to the control condition. We also hypothesized that there would be a differential effect of thermal pain ratings based on their congruence with the thermal impression of the VE.

Methods

This was a 3x 4 (group x VE condition) factorial design. A convenience sample of 36 subjects participated (see table 1): 12 stroke patients without pain, 12 stroke patients with central post-stroke pain (> 2 on a 0 - 10 Numerical Rating Scale) in their upper limb, and 12 pain free control participants. The study procedures were explained to all subjects and an informed consent was signed prior to participation.

Quantitative Sensory Testing

QST was done using the method of limits standard test protocol and the NeuroSensory Analyzer Model TSA-II (MEDOC Ltd., Ramat Yishai, Israel) on the painful and contralateral, pain-free forearm in counterbalanced order to assess pain perception to thermal hot and cold stimuli. The TSA-II uses a 30mmX30mm thermode which was placed on the skin of the patients' forearm. Thermal stimuli were delivered by 15 brief (700ms) taps of stimuli via the thermode. Rate of temperature changes were between 0.3 ºC/ sec and 4.0 ºC/ sec. Temperatures between 36 - 47° C were used for hot stimuli and 30 ºC with a rate decrease of 1º C/sec and an automatic safety lower limit of 4.5ºC for the cold stimuli. In the methods of limits, stimuli (hot or cold) increased in intensity to a specific temperature for less than 1 second and then immediately returned to neutral temperature, in preparation for the next stimulus. Six clusters of stimuli were given, with up to six stimuli in each cluster, so a mean was taken in order to derive the pain rating. Interval between stimuli started from stimulus end to onset of next stimulus which lasted 6 seconds.

Table1: Subjects Characteristics

	Subject Group		
	Control (n=12)	Stroke (n=12)	Stroke and pain (n=12)
Age*	61.83 ± 7.2	65.25 ± 6.39	61 ± 7.21
Females**	7 (58.3)	4 (33.3)	5 (41.6)
Males**	5 (41.6)	8 (66.6)	7 (58.3)
Time after stroke (year) *	--------	3.75 ± 2.3	4.08 ± 2.53

* Values are mean ± SD ** Values are n (%)

Figure 1: Quantitative Sensory Testing device showing contact thermode (http://www.medoc-web.com).

Figure 2. Experimental set up. Note position of contact thermode for QST under forearm, computer mouse controls temperature changes.

Virtual Reality Environments

The VE conditions (Figure 3) were randomly presented. They were as follows: 1) "Snow World" (cold) is an environment used extensively by Hoffman (2001). It has snowy mountain canyon scenes, 2) Dante's Canyon (hot) is a modification of "Snow World. It has interesting red canyon scenes, 3) Neutral is comprised of alternating white pillars on a black background and a rolling ball that appears to draw the individual's attention along the path (Powell, 2006). Since this virtual environment gives neither a hot nor a cold impression, it is likely to be neutral regarding temperature cues, and 4) No VE condition which is considered as the control condition (lights off, eyes closed). Each of the VR conditions lasted approximately 3-5 minutes, and subjects were allowed to rest between each condition. Subjects were passively exposed to each VE just prior to the test and the VE was continued for the duration of the tests followed by hot and cold pain stimuli on both arms. So, participants did not need to do anything with VE conditions and they just viewed the virtual environments while they were presented to the thermal stimulus. The computer was equipped with the ultra-high end NVIDIA Quadro FX 4500 graphics card (512 MB of high-speed GDDR3memory). Each VE was presented through a head mounted display (HMD) (Kaiser Optical Systems, Ann Arbor, MI, USA). To allow the subjects to experience the VE conditions as realistically as possible, we used an ICUBE head-tracking system that provided subjects to look in any direction and different parts of the virtual environments.

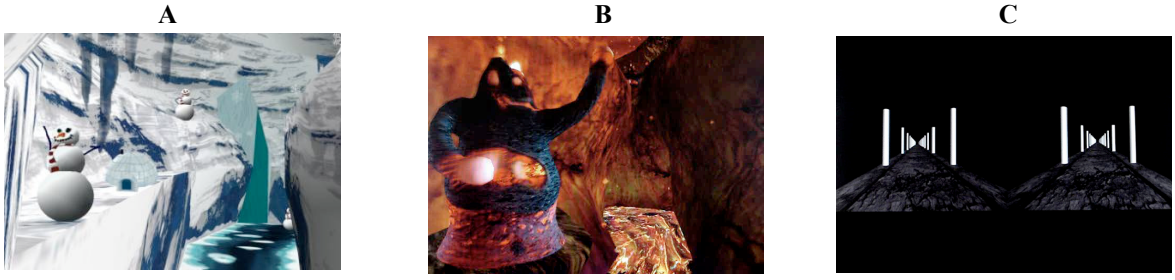

Figure 3: Virtual environments used for experiment: (A) Snow World; (B) Dante's Canyon world; (C) Neutral VE (alternating white pillars on a black background)

Pain rating

To measure pain rating the thermode was fixed at the inner side of the forearm. During each VR period, three hot stimuli and three cold stimuli were delivered via thermode on the participant's arm. Stimuli (hot or cold) increased rapidly in intensity to a specific painful temperature for less than 1 second and then returned to the baseline temperature (32 ºC). After receiving the hot or cold stimulus, participants were asked to rate each stimulus according to their perceived pain intensity on a Numerical Rating Scale ranging from 0 to 100. Zero represented no pain at all and one hundred was the worst pain imaginable. By clicking the mouse, the thermode temperature immediately returned to neutral temperature and the pain rating was recorded. The procedure was repeated six times on the patient's arm area (three hot and three cold stimuli). The mean pain rating was calculated and used for analysis.

Procedures

Experimental procedures were first explained and informed consent obtained. Group assignment was based on the history of stroke and presence (stroke with pain) or absence of pain (stroke without pain). The control group comprised an age matched convenience sample of pain free healthy subjects. All subjects were familiarized with the VR and QST equipment prior to the study. The experiments took place in a quiet air-conditioned environment in which the ambient temperature was stable and comfortable (22°C). Subjects then underwent psychophysical testing of thermal (hot and cold) stimuli using the method of limits standard protocol in order to determine hot and cold pain ratings. Participants then viewed the VE's in random order through the HMD. The hot and cold stimuli were applied and pain rating judgments obtained while viewing the VEs.

Data analyses

Normality of distribution for all data was analyzed with the Kolmogorov-Smirnov test.
Summary descriptive statistics (means, minima, maxima and standard deviations) for demographic and outcome variables were computed and compared for all groups to establish group homogeneity. To analyze the significance of the main effects of group, stimulus, and VE condition on heat and cold pain ratings at each limb location MANOVA (3 x 2 x 4) was performed using SPSS software, version 15. Data were also analyzed with repeated-measure ANOVAs containing the within-subject factors (VR environments and stimulus). Tukey HSD was used for post hoc analyses as appropriate. The sphericity assumption was checked with the Mauchly test. The level of significance was set at alpha level of $p<0.05$.

Results

Pain ratings
Data of pain ratings for the stroke side in each group of study were averaged separately for hot and cold stimuli and for each VR condition. MANOVA was significant for main effects of group and VE condition (2-way interactions) (Wilk's lambda p= 0.039), but there was no interaction among VE condition, group, and type of stimulus (3-way interactions) (Wilk's lambda p= 0.54). Moreover, the interaction between environment and temperature was not significant (Wilk's lambda p= 0.64). For patients with stroke and pain, Dante's canyon decreased pain rating to both hot and cold stimuli ($p < .05$), but other VE environments had no effect (Figure 4). For patients with stroke but no pain, Neutral environment decreased pain rating to both hot and cold stimuli ($p < .05$) (Figure 5). For healthy subjects there was no significant effect of VE albeit there was a trend towards Snow world decreasing pain ratings to hot stimuli, and Neutral environment decreasing pain ratings to cold stimuli (Figure 6). Finally there was no differential effect of VE condition on pain rating to thermal, warm and cool stimuli across the three groups ($p > .5$) when tested on the non-stroke arm in patients with, and without pain as well as one arbitrary arm of the control subjects (see table 2).

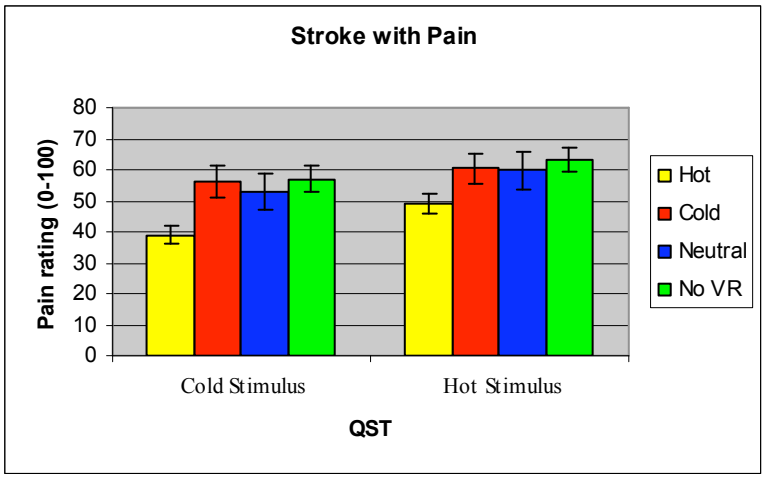

Figure 4: Mean pain ratings of the cold and hot pain stimuli of the patients in stroke group with pain during presentation of the virtual worlds.

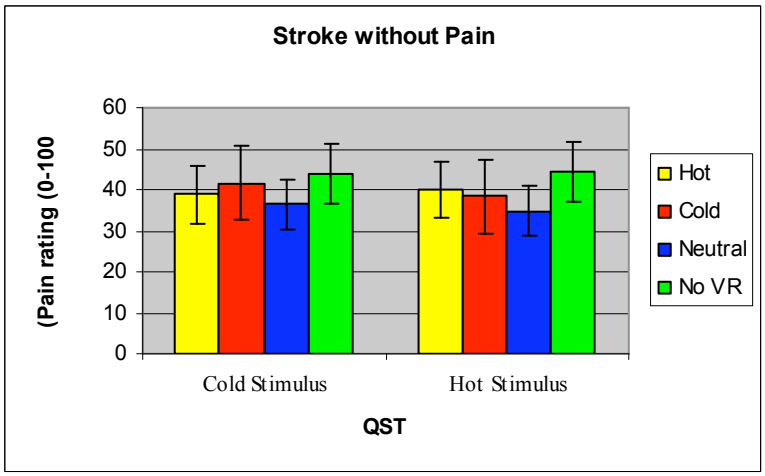

Figure 5: Mean pain ratings of the cold and hot pain stimuli of the patients in stroke group without pain during presentation of the virtual worlds.

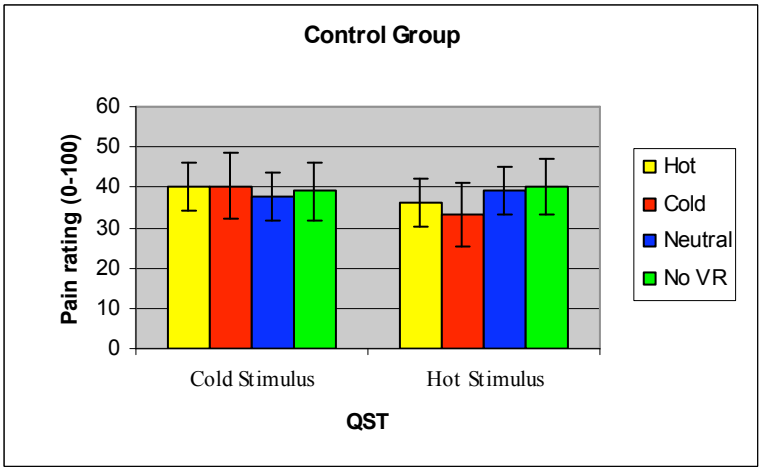

Figure 6: Mean pain ratings of the cold and hot pain stimuli of the patients in healthy group during presentation of the virtual worlds.

Virtual Environments	Control		Stroke without Pain		Stroke with pain	
	Stimulus		Stimulus		Stimulus	
	Cold	Hot	Cold	Hot	Cold	Hot
Hot	41.36±7.5	38.05±6.8	45.59±8.1	45.42±7.5	50.91±5.4	49.02±5.8
Cold	35.97±7.1	32.66± 7	41.20±6.6	43.89±7.2	43.61±8.1	43.36±9.1
Neutral	43.69±8	38.41±7	45.01±7.2	42.84±6.5	53.47±5.8	55.27±5.5
No VR	40.8±7.5	36.97±6.4	48.86±6.6	52.36±7.5	56.44±8.5	52.36±8.2

Table 2: Data of pain ratings for the non-stroke arm in patients with, and without pain as well as one arbitrary arm of the control subjects were averaged separately for hot and cold stimuli and for each VR

Discussion

This study compared the relative effectiveness of different VR conditions on subjective pain ratings to thermal (hot and cold) pain stimuli in stroke patients, with and without pain in comparison to healthy pain free control individuals. In line with our hypotheses, the results indicated that all VR conditions decreased pain ratings compared to the control condition (no VR). In addition, virtual reality appeared to differentially influence experimental pain rating to both hot and cold stimuli in patients with stroke. Dante's canyon (Hot environment) in stroke group with pain and black and white pillars (Neutral environment) in patients with stroke but with no pain were the most effective environments. Moreover, there was no significant difference between hot and cold stimuli on experimental pain rating across groups when tested on the symptom free side.

In the present study, subjects in both stroke groups with and without pain reported a significant decrease in their pain rating during VR exposure, which is consistent with previous reports in subjects using an experimental pain paradigm (Hoffman, 2004c, 2004d). In addition, the results are generally consistent with the results of Muhlberger (2007) who showed the pain experience was reduced in both the warm and the cold virtual environments compared to the control condition. Muhlberger (2007) also indicated that hot stimuli were always perceived as less painful than cold stimuli, regardless of which VR condition was presented. This is contrary to the results of the present study which showed no difference between hot and cold stimuli. However, in both studies the interaction between environment and temperature was not significant. The differences may be due to the subject differences.

The small sample size in this study limits the generalizability of VR analgesic efficacy to larger populations of stroke patients. Individual differences and personal characteristics such as degree of ability to concentrate and immerse in VR environment may also mediate the effectiveness of VR. In addition, interactivity of VR environments may influence effectiveness. More research is needed on whether different types of chronic pains respond differentially especially if the level of interaction is different.

Conclusion

Results revealed that all virtual environments reduced pain ratings for hot and cold pain stimuli compared to a control condition. There was a differential effect of VE in individuals with stroke, based on the presence or absence of pain. Dante's canyon was most effective in the stroke group with pain and a Neutral environment was most effective in patients with stroke but with no pain.

Acknowledgements

The authors thank Canadian Foundation for Innovation Grant and extend special thanks to Michael Waterston and Dr. Najaf Aghaei for help in data collection and analysis.

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Technostress: a research about computer self-efficacy, internet attitude and computer anxiety

Filippo La Paglia, Barbara Caci**, and Daniele La Barbera**

Neuroscience Department, Psychology Department***
University of Palermo

Abstract: *The research gathered 77 teachers' responses about their own perceived computer-expertise, computer self-efficacy, Internet attitude and computer-anxiety. A multiple regression analysis showed that low computer self-efficacy predicts anxiety toward computers, whereas this is not the case of low computer-expertise or low Internet attitude. Hence, psychological treatments should aid computer-anxious people to modify their negative perceptions toward computers and to discover the profitable potentialities of technologies, more than increasing their effective computer expertise or feelings toward the Internet.*

Key words: Technostress, Computer self- efficacy, Computer anxiety

Author for correspondence
Daniele La Barbera – Neuroscience Department, School of Medicine, University of Palermo, via G. La Loggia, N° 1, 90129, Palermo, Italy, tel ++39 091 6555164, e-mail labadan@unipa.it

Introduction

The present paper focused on technostress, which is an emergent psychological disorder experienced by individuals when they interact with technologies (Brod, 1984). Specifically, techno-stressed people affirm to have negative attitudes, thoughts and feelings toward technologies and present also physical and psychological symptoms when they manage directly or indirectly hi-tech products (Weil & Rosen, 1995). Basically, researchers have refereed to technostress using labels such as computer-anxiety or computer-phobia, which stress peculiar forms of technostress related to being uncomfortable with computers usage (Weil & Rosen, 1995). However, meta-analysis on this topic – e.g., technostress – has suggested that all the previous terms rely on the same significance (Chua, Chen, & Wong, 1999). As follows, in the present paper we will use the terms computer-anxiety and technostress as synonyms.

In general, computer-anxiety represents a sort of aversion, fear, apprehension, hostility or resistance toward computers (Anderson, 1996; Gackenbach, 1998; Glass & Knight, 1988; Jay, 1981; Lee, 1986; Meier, 1985; Maurer & Simonson, 1984; Rosen & Maguire, 1990). More appropriately, computer-anxiety have been recently described as a negative emotional state that a person experienced when he/she is using a computer (Bozionelos, 2001; Simonson, Maurer, Montag-Torardi, & Whitaker, 1987). Hence, it represents more a state than a trait anxiety (Cambre & Cook, 1987; Chua et al, 1999), which is characterized by the following behavioral and cognitive symptoms: 1) excessive caution with computers; 2) avoidance of computers; 3) negative remarks about computers; 4) attempts to cut short the necessary use of computers (Mahar, Henderson, & Deane, 1997). Sometimes, typical stress physiological reactions (e.g., sweaty palms, dizziness, shortness of breath) could be also associated with computer-anxiety (Hemby, 1998; Lalomia & Sidowski, 1993; Weil, Rosen & Wulgater, 1990). All the above-mentioned behavioral, cognitive and physiological responses arise not only when the subject interacts with computers but also when he/she thinks a future use of it or he/she looks at others manage a computer (Dyck, Gee & Smither, 1998; Rosen & Weil, 1995). Factorial studies have evidenced that computer-anxiety is a multi-componential dimension (Lloyd & Gressard 1984; Beckers, & Schmidt, 2001). Recently Beckers and Schmidt (2001) have proposed a factorial model based on the following six factors: computer literacy (or computer-expertise), computer self-efficacy,

physical arousal caused by computers, affective feelings about computers, and beliefs both about the beneficial effects of computers and about their dehumanizing aspects. Authors assigned an important role both to computer-expertise and to computer-self-efficacy. Specifically, they argued that computer-anxiety depend basically by these two psychological dimensions that mutually influence both the physical arousal and the positive or negative beliefs about computers (Beckers & Schmidt, 2001; Rosen & Weil, 1995). Similar outcomes have been showed also by correlation studies that reported negative associations of computer anxiety among with computer-expertise, defined as the ability in using a computer or program software such as word-processing, programming languages or operative systems (Gos, 1996; Mahar et al., 1997; Brosnan, 1998; Chua et al., 1999; Bonzielos, 2001) and with computer self-efficacy, described as the individual perceptions about their own ability in using a computer or in performing a task using specific software (Hill, Smith & Mann, 1987; Compeau & Higgins, 1995; Wilfong, 2006). Even though a significant body of research about computer-anxiety exists, the results of most studies are inconsistent as regard the causal inter-relationships between the psychological variables that influenced computer-anxiety (Maurer, 1994). Indeed, computer anxiety has been described both as an antecedent of negative attitudes toward technologies or of low computer-self-efficacy levels (Thatcher & Perrewè 2002), and as a consequence of low computer-self-efficacy levels (Marakas, Johnson, & Palmer, 2000), or of demographical variables such as gender and age (Hemby, 1998; Cooper, 2006), or of personality factors (Brown, Deng, Poole, & Forducey, 2005). Other researches have showed correlations also between computer-anxiety and Internet attitude, which represents the positive/negative attitude toward the Internet. Specifically, people with positive attitudes toward the Internet are also less anxious toward computers (Al-Khaldi & Al-Jabri, 1998; Anderson, 1996; Ayersman, 1996; Harrison & Rainer, 1992; Kay, 1989; Mitra, 1998; Pancer, George, & Gebotys, 1992; Sam, Othman, e Nordin, 2005). But also in this case, no results are reported by the literature about the causal relationships between computer-anxiety and positive or negative Internet attitudes.

Moreover, such controversial panorama about cognitive precursors of computer-anxiety is problematical also because the authors involved populations with different genders and ages in the above-mentioned empirical researches. Then, some authors suggested that adults rather than young people have a lower level of computer self-efficacy (Baack, Brown and Brown, 1991); on the contrary, other researchers showed that younger people rather than adults have a lower level of computer self-efficacy and of computer-anxiety (Klein, Knupfer, and Crooks, 1993). Similarly, studies made on educational contexts, on one hand have demonstrated that students requested to solve computer-mediated tasks reported very high level of anxiety toward computers (Marcoulides, 1988; Harrington, McElroy, & Morrow, 1987; Wirier & Bellando, 1989). On the other hand, researchers have shown that teachers are more anxious than students because they were usually asked to solve technical difficulties related to computer-mediated tasks (McKinnon & Nolan, 1989).

Starting from this divisive state of art, the purpose of this study was to analyze the causal relationships of computer-anxiety among with computer-expertise, computer self-efficacy and Internet attitude in a population of Italian teachers. We started from the assumption that computer-anxiety is a kind of state anxiety, which is influenced more by cognitive variables as negative self-efficacy believes or Internet attitude than by low computer-expertise. Then we would test the hypothesis that low levels of computer self-efficacy and Internet attitude would predict high levels of computer-anxiety. We were interested in exploring cognitive precursors of computer-anxiety in order both to perform useful training programs for teachers involved in computer-mediated projects and to design adequate psychological treatments for prevent the emergence of computer-anxiety.

Methods

Participants

77 teachers (29M; 48F), aged between 28 and 61 years old (mean age 43yr; SD= 9), were casually selected by different primary schools of Palermo. All they volunteered to participate to the research.

Materials and procedures

After registering personal data (e.g., gender, age, instruction, occupation), participants filled the following self-report questionnaires:

- Computer-Expertise Questionnaire developed by Chifari, Ottaviano, D'Amico and Cardaci (2000) – it is an 11-item scale that measures the individuals' technological expertise toward computers and the Internet. Subjects were required to indicate their level of know-how toward computers, the number of software they known, the owning of a personal computer and its usage at home, at work, at school/university, the familiarity with the Internet, the Internet time usage per day. The total score was computed by averaging the scores obtained by the subjects in the scale: higher scores denoted, then, higher levels of computer-expertise.
- Computer Self-efficacy Scale, as re-arranged by Chifari, Ottaviano, D'Amico and Cardaci (2000) from the original Eachus and Cassidy Scale (1997) – it is a 30-item scale that explores the individuals' perception of self-efficacy toward computers. Subjects were required to indicate their level of agreement/ disagreement to each statement along a 6-point Likert scale (from 0=not agree to 6=agree). The total score was computed by averaging the scores obtained by the subjects in each of the items of the scale: higher scores revealed, then, higher levels of computer-self-efficacy.
- Internet Attitude Scale, developed by Sam, Othman and Nordin (2005) – it is a 28-item scale that measures the positive and negative attitudes toward the Internet. Subjects were required to indicate their level of agreement/disagreement to each statement along a 6-point Likert scale (from 0=not agree to 6=agree). The total score was computed by averaging the scores obtained by the subjects in each of the items of the scale: higher scores signified, then, positive attitudes toward the Internet.
- Computer Anxiety Rating Scale, developed by Weil and Rosen (1995) – it is a 19-item scale that investigates the perceptions of stressors associated with computer usage. Subjects were required to indicate their level of agreement/disagreement to each statement along a 6-point Likert scale (from 0=not agree to 6=agree). The total score was computed by averaging the scores obtained by the subjects in each of the items of the scale: higher scores expressed, then, higher levels of computer-anxiety

Participants spent in average from 15 to 20 minutes at filling all questionnaires. Data were collected in fall 2008.

Statistical analysis

All data were analyzed using SPSS 8.0 (SPSS Inc., Chicago IL). Descriptive statistics were computed to describe demographic characteristics of participants. To examine the contribution of computer-expertise, computer self-efficacy and Internet attitude to the explanation of variance in computer-anxiety a multiple regression analysis, using the enter method, was performed on participants' averaged scores

Table 1 - Participants' Mean Averaged Scores and Standard Deviations at Computer-Expertise Questionnaire, Computer Self-efficacy Scale, Computer Anxiety Rating Scale and Internet Attitude Scale (N=77).

	Mean	SD
Computer Expertise Questionnaire	2.5	0.7
Computer Self-efficacy Scale	4.4	0.9
Internet Attitude Scale	3.9	0.5
Computer Anxiety Rating Scale	2.4	0.6

As reported previously (Table 1 above), participants scored lower on Computer-Expertise and Computer-Anxiety and scored higher on Computer Self-Efficacy and Internet Attitude. Hence, Italian teachers exhibit moderate levels of computer-expertise, but perceive themselves as highly efficiency in computer usage. Moreover, they reveal positive attitudes toward the Internet and low levels of computer-anxiety.

In order to investigate the contribution of computer-expertise, computer self-efficacy and Internet attitudes to the explanation of variance in computer-anxiety, Gauss-Markov assumptions were preliminary verified and correlations among all questionnaires were calculated. Table 2 reported correlations among all questionnaires (*Pearson's r*).

Table 2 - *Pearson's* Correlations between Computer-Expertise, Computer-Self-Efficacy, Internet Attitudes and Computer-Anxiety Questionnaires (N=77)

	1	*2*	*3*	*4*
Computer- Expertise (1)	—			
Computer Self-efficacy (2)	.453*	—		
Internet Attitude (3)	.408*	.360*	—	
Computer Anxiety (4)	-.525*	-.641*	-.554*	—

Note - * Correlation is significant at the 0.01 level (2-tailed).

As can be seen from the Table 2 (above) results showed positive correlations between Computer-expertise/Computer self-efficacy (r=.45; p<.01) and Computer-expertise/Internet Attitude (r=.40; p<.01). Similarly, a positive correlation of .36 (p<.01) has emerged between Computer self-efficacy/Internet Attitude. On the contrary, negative correlations have emerged between Computer anxiety/Computer-expertise (r=-.52; p<.01), Computer anxiety/Computer self-efficacy (r=-.64; p<.01) and Computer anxiety/Internet Attitude (r=-.55; p<.01).

Successively, a multiple regression analysis using the enter method was performed on the participants' average scores. In turn, the R^2 value for the whole model was determined during the analysis. Results at the multiple regression analysis (see Table 3) showed that the three predictors (i.e., computer-expertise, computer self-efficacy and Internet Attitude) explain approximately 69% (R^2=0.69) of *computer-anxiety.* The model was significant at level 1% - $F_{(3, 73)}$ = 54.48; p<.0001. Specifically, low scores on Computer-Self-efficacy scale (β=-.046; p<.01) significantly predicted computer-anxiety. Moreover, scores on Computer-Expertise Scale and Internet Attitude Scale didn't predict significantly computer-anxiety scores (see Table 3).

Discussion and Conclusion

The present paper suggests important outcomes for studying psychological antecedents of computer-anxiety.

Consistently with the literature (e.g., Bonzielos, 2001; Chua et al., 1999; Compeau & Higgins, 1995; Wilfong, 2006), computer-expertise is significantly positively associated with computer self-efficacy. Furthermore, computer-anxiety is significantly negatively related to computer-expertise, computer self-efficacy and Internet attitude. Also this last result is coherent with literature outcomes (e.g., Sam, Othman, e Nordin, 2005). Interestingly, our correlation data showed also significant positive correlations between Computer-expertise/Internet Attitude and Computer self-efficacy/Internet Attitude. As follows, individuals' predispositions towards the Internet are associated both to their effective skills to interact with a computer or to manage its unexpected difficulties and to their own capabilities to feel able of using it. As demonstrated by regression analyses performed on participants' averaged scores on the considered questionnaires, computer-anxiety depends more on psychological competences of efficacy toward technologies then on effective technological skills in computer usage. Similarly, attitudes toward the Internet seem not to influence the individuals' computer-anxiety levels. Specifically, computer-self efficacy is the ability to manage technologies satisfactorily, as well as to feel confident towards technology. This is responsible for the reduction of computer-anxiety individuals' levels. From a theoretical point of view, our outcomes are coherent with the well-known model of self-efficacy proposed by Bandura (1977; 1986). Indeed, as suggested by Bandura (1977; 1986), higher levels of self-efficacy lower anxiety that individuals perceive independently of a specific domain. Our study suggests a very different point of view for possi-

Variables	B	SE B	B
Computer-Expertise	.147	.02	.005
Computer Self-efficacy	-.370	.04	-.81*
Internet Attitude	-.231	.07	-.02
Note: R^2= .69; F (3,77) = 54.48; p<.0001. *p<.01			

Table 3 - Summary of General Regression Analysis for Variables Predicting Computer-Anxiety (N=77)

ble psychological treatments aimed at reducing individuals' levels of computer-anxiety. In this sense, we believe that de-sensitizing psychological treatments could be oriented not to enlarge individuals' *cold* technological notions or their expertise toward computer, as proposed by the current literature (e.g., Sam, Othman, & Nordin, 2005), but to step up individuals' self-confidence beliefs to manage such peculiars technologies such as computers and the Internet. Moreover, training programs about technologies that involve mainly teachers should be based on the improvement of individuals' trusts toward technologies more then on the improvement of mere technological skills. Only in this way, we guess that could be prevented the emergence of individuals' computer-anxiety.

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Original Research

Factors affect on cyber cafe addiction of undergraduate students in Taiwan

Hui-Jen Yang [1] Justin S. Lay[2] Yun-Long Lay[3]
[1] Professor, Department of Information Management, National Chin-Yi University of Technology, Taiwan
yanghj@ncut.edu.tw
[2] Undergraduate, Department of Computer Science and Information Engineering, Tunghai University, Taiwan
s942844@thu.edu.tw
[3] Professor, Department of Electronics, National Chin-Yi University of Technology, Taiwan
yllay@ncut.edu.tw

Abstract: *Cyber-café activity became one of the most important entertainment activities in the Taiwanese society in the last couple of years. [Along with the advent of cyber cafés came serious social problems?] It also created some serious social problems. However, there is little understanding of the factors affecting the causes of cyber-café addiction. This article focuses on the impact of family factors in cyber-café activity. Collected data was used to study the effects of family environment such as parental support and socioeconomic status (SES), Internet self-efficacy, and failure tolerance on cyber cafe addiction in undergraduate students. A questionnaire method by self-administered technique was used in this research. Multiple regression analysis was used to analyze the hypotheses. Hypotheses results showed that Internet self-efficacy, failure tolerance, and parental support have predictive power over cyber cafe addiction. Some implications of the results on cyber-café addiction are also discussed in this study.*

Key Words: *Socioeconomic Status (SES); Internet self-efficacy; Addiction Theory; Social Status; Cyber cafe Addiction*

Introduction

With the prevalence, popularity and wide-spread promotion exponentially of the Internet in recent years, many previous reports indicate that adolescence were becoming addicted to internet overuse (Chake & Leung, 2004; Campbell, 2006;Griffiths, 1996; 2000; Hall & Parsons, 2001; Liu & Kuo, 2007; Pratarelli & Browne, 2002;1999), computer addiction such as involving obsessive computer game playing on games (Young, 1999), network gambling (Mobilia, 1993) and obsessive video game playing (Keepers, 1991; Chiu et al., 2004). What makes the cyber-café activity in Internet so alluring? Some arguments proposed to answer this question. First is the feature of anonymity, namely nobody knows who you are while you are on the line. You can use nickname surfing everywhere on the line. Second is the function of convenience because if you have money and find a cyber-café store's computer and hook on the network, you have the access to the world at your fingertips. Third is the property is that of escaping if an individual had a bad day or is in low spirit, he or she may find relief by getting on the cyber-café Internet. Fourth is the private space in cyber-café store nobody knows you. While playing computer games or chatting on line, your parents or friends wouldn't interfere with you.

Recently, cyber cafe video or computer games are a novel and became a popular leisure and business industry in Taiwan. Cyber cafe is a similar to the traditional coffee shop and is equipped with network facilities and provides different kinds of video or computer games playing in stand-alone computers or 24 hour Internet access. These kinds of stores attract adolescence and even young married men or women that spend their leisure time in the cyber cafe

video or computer games. Based on the annual reports of MIC in 2006, over 85% of high school and university's students participate in these cyber café activities and spend on average 2-8 hours per week in cyber-cafés playing mostly games (around 80%), chatting and surfing the Internet comes next (MIC, 2006). The cyber-café addiction activity has jeopardized or interfered with the adolescence life and social development and contributed toward many social and family problems that occur. In addition, some adolescents became so addicted to the video and computer games that they fail academically (Brady, 1996) or demonstrate substandard performance (Young, 1996). This can be symbolized in the Chinese idiom "a rising tide lifts all boats; a sinking ship will get everybody wet". So, cyber-café addiction and the associated behavior are emerging as a new problem for society, school and families in Taiwan. Parents and teachers alike are deeply troubled by this new alarming phenomenon. However, until very recently, empirical data addressing video or computer game addiction behavior in cyber cafes was still lacking and not been thoroughly empirically researched.

There exists ample research that suggests that socioeconomic status and the family environment (ie. parental support) have a significant influence on the support available to children (Pickvance & Pickvance, 1995; Rogers & Pryor, 1998; Dey & Morris, 1999). When children or adolescences have a bad day or are in low-spirit and that they can't handle they usually choose to escape and find a way to release their emotion. Thus, the cyber café store probably is the place the children or adolescences choose to go.

The concept of self-efficacy is an important factor to measure how an individual quickly adopts new tools and one's belief in capability to perform a task (Bandura, 1986). Many MIS researchers have used self-efficacy in studies of understanding computer use or acceptance (Hong et al., 2002; Venkatesh & Davis, 1996). Bandura (1986) suggests that choice behavior is stimulated by one of the personal efficacy beliefs that people engage in tasks in which they feel competent and confident and avoid those in which they do not. However, no previous research discussed the impact of internet self-efficacy on cyber café addiction behavior. There is a need for studies to understanding the relationship between internet self-efficacy and addiction behavior. Therefore, the purpose of this exploratory study was to investigate the affecting factors in cyber cafe video or computer game addiction behavior pattern. Another purpose was to explore the mediator effects of internet self-efficacy on cyber cafe video or computer game addiction behavior. Additionally, this study also hopes to alert the attention of parents, school, and government to seriously look at the problems caused by cyber-café addiction behavior.

Related Literature and Research Model

Cyber cafe addiction

Mentioned the concepts of addiction, people will usually think of drugs or alcohol addictions. Thus, previous research about addiction research focused on the problems of material addiction. However, psychologist observed the addiction phenomenon on behavioral side which involves human-machine interaction, such as gambling (Mobilia, 1993), computer overuse (Griffiths, 1996), overeating (Lesieur & Blume, 1993), network or internet addiction (Young, 1996; Pratarelli & Browne, 2002;1999; Liu & Kuo, 2007; Chake & Leung, 2004; Campbell, 2006), or obsessive video game playing (Keepers, 1991; Chiu et al., 2004). The core components of behaviourial addictions include salience, mood modification, tolerance, withdrawal, conflict and relapse (Griffiths, 1996).

Thus, based on the addiction definition of Griffiths (1996), in this study any behavior meets the following criteria called cyber-café addiction: 1. salience: when cyber-café activity becomes the most important activity in his/her life and dominates his/her thinking, feeling or behavior.; 2. mood modification: subjective experiences people report as a consequence of engaging in cyber-cafe activity; 3. tolerance: the process whereby increasing amounts of the cyber-cafe activity are required to achieve the desired effects; 4. withdrawal symptoms: unpleasant feelings, state, or physical effects when the cyber-cafe activity is stopped or curtailed; 5. conflict: conflicts between cyber-café addicts and those around them, conflicts with other activities, or conflicts within the individuals themselves; 6. relapse: the tendency for repeated reversion to earlier patterns of the cyber-café addictive activity to recur.

Young (1996) developed a brief eight-item questionnaire to examine Internet addiction such as do you feel preoccupied with the internet?;do you feel restless, moody, depressed, or irritable when attempting to cut down or stop Internet use?, and so on. Hence, in this study we define cyber cafe addiction behavior as "people feel restless, depressed, or irritable when attempting to cut down or stop going to cyber cafe store to play video or computer game, surf, or chat in network."

Family Environment

Parental support

Family is the first and foremost context for children's physical and psychological development and parents have always seemed playing a paramount importance relating to children's personality development and material support (Lu & Lin, 1998; Dey & Morris, 1999). In general, parental supports encompass a variety of forms, such as financial assistance, provision of accommodation, personal care, including emotional and moral support, and practice assistance (Dey & Morris, 1999). Help to increase self-confidence, emotional and informative support and guidance in stress-filled situations are aspects of parental support to children receiving most attention in the literature (Stronegger et al., 1997).

Parental support is one of the dimension of social support, and social support is usually defined as the existence or availability of people on whom we can rely, people who let us know that they care about, value, and love us (Sarason et al., 1983). Thus, social support has been identified as a resource that enables individuals to cope with stress (Russell et al., 1987; House, 1981). The research of Liu & Kuo (2007) supported that the more the discontent with peer interactions the participants experienced, the more addicted they are to the internet. Their research also displayed that parent-child relationship influenced internet addiction. Previous research demonstrated that perceived adequacy of social support has repeatedly been found to relate positively to mental and physical health (Barrera, 1981; Fiore, et al., 1986). Campbell et al. (2006) research presented that social support is negatively related to internet addiction. Thus, we generate the hypothesis 1:

H1: The greater the student's perception of parental support, the lower his/her cyber cafe addiction behavior.

Social-economic status (SES)

Education and income are two aspects of socio-economic status that are most important to psychological well-being (Mirowsky & Ross, 1990). Thus, in this study, social-economic status was defined as the level of education and income of parents. Mirowsky and Ross (1990) assert that high levels of income, education, occupational status and job autonomy are associated with an increased sense of control. This finding raises the possibility of association between addiction behavior on cyber cafe video or computer game

and socioeconomic status. That means, if students come from higher socioeconomic status family, they have higher sense of control to avoid indulging in the cyber-café activities. Parents in high socio-economic status will put more effort into or cares more about their children's' mental well being. Generally speaking, children within loving environment will have high self-confidence and not easily indulge in cyber-café addiction. Higher socioeconomic status could be associated with lower cyber cafe video or computer game addiction behavior, whereas lower socioeconomic status could be associated with higher cyber cafe video or computer game addiction behavior. Thus,

H4: The higher the student's family socioeconomic status, the lower his/her cyber cafe addiction behavior.

Internet self-efficacy

Bandura (1986) defined self-efficacy as "people's judgment of their capabilities to execute courses of action required to attain designated types of performances." Bandura (1986) found that self-efficacy positively correlates with behavioral changes both vicariously and emotively. Bandura also suggested that personal efficacy expectations resulted in choosing activities that avoid a task or indulge in the task. Previous research indicated that the predictive capability of a self-efficacy estimate is more accurate in specific domain-related measures than with general measures (Bandura, 1989). In this research, internet self-efficacy scale, modified from Yang et al.'s Internet self-efficacy (2007), examines perceptions of internet skills or abilities. Therefore, internet self-efficacy was defined as "people's judgment of their capability or confidence to master the Internet or World Wide Web". Computer skill level is an important determinant in computer use, employee replacement and selection, education, training, hardware support and software support (Harrison et al., 1992). Based on the theory of self-efficacy and previous researches cited above, we presume that students have a greater internet self-efficacy, have a lower level of addiction. Thus,

H2: The greater the student's internet self-efficacy, the lower his/her cyber cafe addiction.

Bandura (1986) suggests that verbal persuasion is one source of information about personal self-efficacy. Bandura (1986) defined verbal persuasion as "the belief, attitude, and behavior of people's judgment of their capabilities to complete the tasks." According to Bandura, self-efficacy expectation is induced through verbal persuasion. If the verbal persuasion is positive, encouraging, and not commanding, the verbal persuasion will enhance personal self-efficacy (Marakas et al. 1998). Thus, we assume if parent's support and encouragement is positive, then students would gain more confidence in their network capability; if negative, then students would lose confidence in their network capability or ability. We therefore, assume that parent's support have a positive relation on student's internet self-efficacy. This leads to:

H3: The greater the student's parental support, the higher his/her internet self-efficacy.

Failure tolerance

Traditionally, failure was treated as negative indication such as learned helplessness, high absolute error-making, and low normative performance. Weibe (1991) defined failure tolerance as a tendency to persist while facing failure or difficulty. Helplessness will slacken one's learning or working motivation or efforts. However, if a person has a higher failure tolerance, he or she has a high motivation to overcome the problems they face. Laux (2000) asserted that a person who has a lower failure tolerance would have a lower tobacco control and would smoke more. Pratarelli & Browne (2002) proposed that addiction affected personal goals. Thus, in this

study we assume that if a student has a lower persistence of failure tolerance, he/she would be more likely indulged in cyber café activities to escape from school or works. However, if a student has a higher persistence to tolerate failure, he/she would not likely indulge in cyber café addiction behavior. This leads to:

H5: The higher the student's failure tolerance is, the lower his/her cyber cafe addiction behavior.

Methodology

Data Collection and Samples

The samples were voluntary college students in technical-vocational college or university at central of Taiwan. A questionnaire using the self-administered technique to collect data for the variables described was developed and pilot tested with 15 sophomore students. The pilot test results in some revisions in wording of questionnaire questions for clarity, then the questionnaires were sent to 5 schools, 13 classes and 686 questionnaires were collected and left 508 valid questionnaires. The usable rate is approximately 72%, including 263 male students and 245 female students.

Reliability and Validity of the Measurement Instrument

A 7-point Likert scale was to estimate each construct. Cyber cafe addiction was measured by 8 items with two subscales, addiction experience and addiction frequency respectively. These items were revised from Chen et al. (1999) and Novak et al. (1997) scales. The Cronbach's t alpha for the overall cyber cafe addiction is .90, cyber cafe addiction experience is .87, and cyber cafe addiction frequency is 92. Parental support was modified from Interpersonal Support Evaluation List (Cohen et al, 1985) and measured by 20 items with two subscales: appraisal and belonging, to estimate student's own perceived degree of parental support. The Cronbach's alpha for the parental support is .86. Internet self-efficacy scale measured student's network capability and was revised from Yang et al.'s Internet self-efficacy scale (2007). The Cronbach's alpha for the internet self-efficacy is .94. Failure tolerance contained 11 items with two subscales to estimate daily life failure tolerance and academic failure tolerance. These items were all revised from Weibe's failure tolerance scale (1991). Cronbach's alpha for the failure tolerance was.81. SES was developed by National Center for Education Statistics (1996) and consisted of family income, parents' educational level, and parents' occupational prestige.

An exploratory factor analysis (EFA) was assessed to check discriminant validity (Kerlinger, 1986). The principal component analysis was used to process factor initially. The second step is using varimax as orthogonal rotation and Eigen value equaling to 1 to get factor loading which should be greater than 0.5 (Kaiser, 1958). If an item with factor loading values is less than 0.5, then the item should be abandoned from further analysis. In the cyber cafe addiction construct, one item related to addiction frequency had loading of less than 0.5 and was deleted. The results of each independent construct, seven items related to parental support, five items related to failure tolerance, and two items related to Internet self-efficacy, have loading of less than 0.5 and were deleted to fit the literature supported (Kaiser, 1958).

Results

Demographics

The participants included 263 males and 245 females. Mean ages were 22 for males, and 24 for females. Student's academic average grade score within 74 to 79 occupied higher percent in this study. Most respondents go to cyber cafe store because they have nothing to do and no net at home have higher percentage in this research. Most of respondents spent less than 2

hours per week in the cyber cafe store. Time to play or know cyber cafe store is within 1 year around 55%. That means, most of respondent is novice in cyber café activity. Respondents go to cyber cafe store for chatting and playing games around 64.8%. Age 21-24 has a higher cyber-café addiction than other age groups. Academic performance of 60-64 has the highest cyber-café addiction. Stress is one of the important reasons why they go to a cyber-café and get addict. The second child in the family has higher cyber-café addiction than other children in the same family. The average hours' students spend 13-18 hours per week at a cyber café. Students with over two years' cyber-café experiences have a higher cyber-café addiction. Students who want to make friends have a higher cyber-café addiction than other groups. Data were further analyzed to examine the levels of cyber café addiction behavior for male and female respondents. Mean score for male and female were 9.83 and 7.95 suggesting a significant difference with a *t* value= 5.200 at 0.001 on cyber café addiction. Gender difference appears to influence the individual who tend to display cyber-café addiction.

Hypotheses testing

Multiple regression analyses were chosen as an appropriate procedure to test the possible relationships among the variables identified as having effect on cyber cafe addiction. The regression results of parental support on internet self-efficacy suggest that respondents with higher parent's support have positively higher levels of internet self-efficacy. The regression results of cyber cafe addiction at $F=9.522$ ($p<.001$). Failure tolerance is the most significant predictive variable for cyber cafe addiction, followed by internet self-efficacy, and then parental support, so H1, H2, and H5 are supported. SES does not have a significant effect on cyber cafe addiction behavior, thus H4 is not supported in this research.

Discussion and Conclusion

The primary purpose of this research was to examine the parental support, internet self-efficacy, socioeconomic status, and failure tolerance to predict cyber cafe addiction. We trust that the results could awaken the awareness and attention of parents, schools, and government by seriously looking at the problems or issues caused by cyber-café addiction.

Taken together, these findings show that internet self-efficacy, parental support, and failure tolerance are significant indicators of cyber café addiction. Failure tolerance has the most significant predictive power. This result indicates that students indulge in cyber-café activities probably because of their failure to fulfill their major role obligation at school or home. As we have seen in this study, the results illustrated that students with a higher failure tolerance and a higher parental support have a lower addiction behavior respectively, and vice versa. These findings are consistent with earlier research that has demonstrated a link between failure tolerance and parental support on addiction behavior respectively (Stronegger et al., 1997; Pratarelli & Browne, 2002; 1999; Fiore, et al., 1986; Campbell et al., 2006; Chiu et al., 2004). The better the parent-child relationship is, the less the internet addiction is (Liu & Kuo, 2007). This indicated that parents should spend more time to pay more attention to their children's behavior. Additionally, the family or school should also assist students to handle failure tolerance to avoid the addiction. Prevention programs should be incorporated in the regular school curriculum to enhance student's self-esteem.

However, an unexpected result was also found. Internet self-efficacy has a positive relationship with cyber café addiction. This result is not consistent with the previous study (Bandura, 1986; Campbell et al., 2006; Chak & Leung, 2004). It is not clear why there seem to be a positive cor-

relation between internet self-efficacy and cyber café addiction. One possible explanation might be that student who has a higher self-efficacy has a higher motivation to challenge the video game to show-off his/her capability in computer. Therefore, they devote more time to games and thus have a higher addiction in cyber café activities. SES does not seem to have a significant effect on cyber cafe addiction. One possible argument is that the cost of going to a cyber-café is relatively speaking not so significant, only NT$20 (around 50 cents US dollars) per hour and could be afforded by most undergraduate students' families. Evidently, cyber-café activities attract most students regardless of their socio-economic status. This research also offers the mediating effect of internet self-efficacy on cyber cafe addiction. The parental support has a positive relationship to internet self-efficacy. Such a link is hypothesized by self-efficacy theory (Bandura, 1986) and certainly has been consistent with previous research (Marakas et al., 1998).

Regardless of what we call it, cyber-café addiction currently is a new emerging issue in the Taiwanese society. Cyber-café addiction exists for a large proportion of adolescence and causes many negative consequences. As have been argued, the cyber-café is an excessive, addictive, obsessive and compulsive behavior. Students who lacks parental support or who have excessive internet self-confidence, even lower failure tolerance are easily addicted to cyber-café activity and cause many social problems. Enhancing family and school education can inhibit the adolescence's cyber-café addiction and simultaneously reduce social problems. Some prevention programs should be implemented to reduce the addiction. From a government perspective, the government should establish some rules to administer cyber-cafés. The school contribution should include periodically counseling seminars or programs to teach students how to arrange and manage their leisure time, or raise and improve their self-control etcetera. Family counseling programs, support groups from parents or school and educational workshops for addicts to help them understand the impacts of cyber-café are needed in the long run to cope with cyber-café addiction.

Acknowledgement

The author would also like to thank that this work was supported by the National Science Council of Taiwan, ROC under Grant No. NSC-96-2416-167-006

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Italian bloggers' stories. their personalities and interpersonal relationships quality

Giovanni Ferraro, *Barbara Caci, Francesco Conti, Marie Di Blasi* and *Maurizio Cardaci*

Dipartimento di Psicologia, Università degli Studi di Palermo

Abstract: *Personal blogs represent a new emergent phenomenon that draws attention of psychologists. In this framework, the present paper discusses the opportunity of evaluating both bloggers' personalities and their social relationships quality using blog as a new research methodology. Blog usage data, Big Five personality traits, Interpersonal relationships quality and Internet addiction were evaluated in a population of 30 Italian bloggers. Results about Big Five personality traits showed no specific personality patterns leading people to become bloggers. However, Italian bloggers describe themselves as individuals considerably open to experience, very affiliative or friendly and capaable of managing their interpersonal problems. Despite their intensive blogging, they also exhibited low levels of Internet Addiction. Further qualitative researches, however, should be performed for deeply analyzing how bloggers manage their self-image.*

Introduction

Some studies have analyzed *blog* as a new emergent phenomenon. Authors attempted to estimate the extension of blogosphera - i.e., the number of blog creators - and have proposed also various classifications of blogs (Bloom, 2003; Herring, Scheidt, Bonus, & Wright, 2004). Other researchers have also focused on blogs' contents and have differentiated between political blogs (Drezner & Farrell, 2004; Lawson-Borders & Kirk, 2005; Trammell, Williams, Postelnicu, & Landreville, 2006), educational blogs (Deitering & Huston, 2004; Dron, 2003; Schroeder, 2003; Trammell & Ferdig, 2004), commercial blogs (Dearstyne, 2005; Kelleher & Miller, 2006; Seltzer, 2005) and personal ones (Blood, 2002; Miura & Yamashita, 2007; Qian & Scott, 2007). Recently, authors have paid attention more on *bloggers* than on blog describing their gender and age differences (Henning, 2005; Huffaker & Calvert, 2005; Huffaker, 2006), or motivations and needs that lead people to create a blog (Nardi, Schiano, Gumbrecht, & Swartz, 2004; Schroeder, 2003). However, there is still not enough data for understanding the psychological implications of personal blogs. Personal blogs represent diary-like online spaces where individuals disclose themselves sharing with others experiences, thoughts and feelings about their lives (Nardi, Schiano, Gumbrecht, & Swartz, 2004; Qian & Scott, 2007). Differing from the traditional diaries where individuals hide their Selves, bloggers use the Internet as a new form of interpersonal interaction to disclose themselves to other people. In this sense, personal blogs represent virtual sources of social relationships that allow users to make of public domain their personality declinations (Blood, 2002; Miura & Yamashita, 2004). When bloggers make a Post on their blogs - i.e., an entry on personal or other topics - they think about and express themselves keeping in mind all their potential readers. Sometimes bloggers solicit feedback from readers, inviting them to comment on their ideas. At the same time, blog readers overwrite bloggers' personal thoughts. As follows, the whole activity of writing about themselves on a personal blog becomes not a solitary and private reflection, but an interactive act that involves both bloggers and readers (Karlsson, 2006). In this perspective, blogs create a new connective context of self-expression, self-construction and self-disclosure (Döring, 2002; Qian & Scott, 2007). Hence, blogs become for psychologists a new and interesting instrument for studying and describing individuals' personalities and social relationships quality. Indeed, using blogs as a research methodology (Mortensen & Walker, 2002), researchers have the opportunity to collect non-intrusive data about intra-personal and inter-personal bloggers' psychological dimensions in a different way from the traditional paper-and-pencil techniques.

In this framework, we made an online pilot study aimed at investigating the relationships between personality factors, interpersonal involvement and blog usage in a population of Italian blog-

Correspondence: Marie Di Blasi, Dipartimento di Psicologia, Università degli Studi di Palermo, Viale delle Scienze – Edificio 15 - 90128 - Palermo (Italy), e-mail: diblasim@unipa.it

gers. A further goal was to explore the association between the quality of blog usage and the Internet Addiction risk of the participants. To this specific aspect, we were interested in evaluating the consequences for individuals' social lives due to their strong involvement in blogging. Our purpose was basically explorative, so a descriptive (both qualitative and quantitative) approach was used.

Methods

Participants

30 Italian bloggers (16M; 14F; mean age 29.8 years; DS=8.9; range 17-53) were recruited online and took voluntary part in the research.

Materials and procedures

A digital framework named "Blog Stories" was arranged for the purpose of the present study and advertised on the most popular Italian blog hosting provider (i.e., Splinder). Bloggers who volunteered to participate in the research were requested to register their personal data (e.g., gender, age, instruction, occupation) and to answer to an 8-item *Blog Usage Scale* (Blog time per day; blog motives, number of personal and frequented blogs). Successively, they were had to fill the following self-report instruments:

- *Personality Inventory (PI)* - including 20-items selected inside by the current Big Five Personality questionnaires (Costa & McCrae, 1992). This 20-item mini scale was aimed at exploring the following personality dimensions: Extraversion, Emotional Stability, Conscientiousness, Agreeableness and Openness to Experience. For each item, subjects chose among five alternatives in a Likert scale (never, rarely, occasionally, often, always like me) corresponding to scores of 0–4. For each scale, the total score was computed by averaging the scores obtained by the subjects in each of the items of the scale: higher scores indicated the persons' level expressiveness of traits in the different personality domains.
- *Inventory of Interpersonal Problems - brief version (IIP32)* - A 32-item questionnaire developed by Horowiz, Alden, Wiggins and Pincus (2000) in order to identify the persons' most salient modalities of interpersonal relationships (Domineering/Controlling; Vindictive/Self-centered; Cold/Distant; Socially Inhibited; Nonassertive; Overly Accomodating; Self-Sacrificing and Intrusive/Needy). For each item, subjects chose among five alternatives in a Likert scale (never, rarely, occasionally, often, always like me) corresponding to scores of 0–4. For each scale, the total score was computed by averaging the scores obtained by the subjects in each of the items of the scale: higher scores indicated the persons' level of expressiveness of the eight different interpersonal domains. The IIP32 total score was computed by averaging the scores obtained by the subjects in each of the scales: higher scores indicated the persons' level of distress in the management of interpersonal relationships.
- *Internet Addiction Test* (*IAT*) developed by Young (1996) - a 20-item questionnaire aimed at measuring individuals' mild, moderate, and severe levels of Internet Addiction. The IAT total score was computed by averaging the scores obtained by the subjects in each of the items: higher scores indicated the emergence of an Internet addiction.

In total, participants took about 30 minutes to fill all questionnaires. Data were collected in Fall 2007.

Statistical analysis

All data were analyzed using SPSS 8.0 (SPSS Inc., Chicago IL). Descriptive statistics were computed to describe demographic characteristics and Blog usage of Italian bloggers. To examine intercorrelations between the different dimensions of personality factors, interpersonal problems, Internet Addiction levels and number of blog owned and frequented by the examined population of bloggers, Spearman's Rho rank correlation coefficients were calculated.

Results

Demographic description of participants and Blog Usage

The group of Italian bloggers was 55% male and the average age was 29.8 years (SD=8.9; range 17-53). Most respondents, about 46.67%, were students. Participants affirmed that they became bloggers from one year (53%) and that they blog less then one hour per day (73%). Moreover, they stated to have only one blog (70%) and frequent three blogs of other people (60%). Furthermore, they use blogs usually for sharing opinions (37%) and experiences with others (27%).

Interestingly nobody affirmed to use the blog as an instrument of self-exhibition.

Intercorrelations between Blog Usage, Personality, Interpersonal relationships quality and Internet Addiction level of Italian bloggers.

Table 1 - Participants' Mean Averaged Scores and Standard Deviations at Personality Inventory, Inventory of Interpersonal Problems and Internet Addiction Questionnaire (N=30).

	Mean	**SD**
Personality Inventory		
Extraversion	2.28	0.64
Emotional Stability	2.33	0.55
Conscientiousness	2.40	0.66
Agreeableness	2.25	0.43
Openness to Experience	2.59	0.63
IIP32		
Domineering/Controlling Subscale	0.91	0.83
Vindictive/Self-centered Subscale	1.00	0.60
Cold/Distant Subscale	1.23	0.80
Socially Inhibited Subscale	1.31	0.87
Nonassertive Subscale	1.07	0.80
Overly Accommodating Subscale	1.89	1.02
Self-Sacrificing Subscale	1.61	0.84
Intrusive/Needy Subscale	1.24	0.64
IIP32 Total score	1.28	0.49
Internet Addiction Test		
IAT Total score	2.28	0.64

As can be seen from the Table 1 (above), results about Big Five PI indicate that the whole group of Italian bloggers obtained average scores in all the considered dimensions. Moreover, Italian bloggers describe themselves as individuals not distressed in the management of their interpersonal relationships (IIP32 total mean averaged score= 1.28; SD=0.49). Specifically, results about interpersonal relationships quality showed that the whole group of Italian bloggers affirm to be neither manipulative (IIP32 Domineering/Controlling subscale), angry or irritable (IIP32 Vindictive/Self-centered subscale), "cold" (IIP32 Cold/Distant subscale), or timid or embarrassed (IIP32 Socially inhibited subscale). Furthermore, they sustain to be assertive (IIP32 Non assertive subscale), not excessively deferential with others (IIP32 Overly accommodating subscale), affiliative (IIP32 Self-sacrificing subscale) or intrusive (IIP32 Intrusive/Needy Subscale). Finally, concerning Internet addiction, results showed a moderate level of IAT in the group of Italian bloggers (IAT mean averaged score=2.28; SD=0.649).

	N° OB	N° FB	E	ES	C	A	O	D/C	V/S	C/D	SI	NA	OA	SS	I/N	IIP-32	IAT
N° of owned blogs (N° OB)	—																
N° of frequented blogs (N° FB)	.169	—															
Extraversion mean score (E)	-.044	.258	—														
Emotional Stability mean score (ES)	.117	-.064	—	—													
Consciousness mean score (C)	-.028	.189	—	—	—												
Agreeableness mean score (A)	-.242	-.278	—	—	—	—											
Openness to Experience mean score (O)	-.064	**.451***	—	—	—	—	—										
IIP32 Domineering/Controlling mean score (D/C)	.288	-.020	.004	.066	-.239	-.193	.152	—									
IIP32 Vindictive/Self-centred mean score (V/S)	.085	**.452***	-.177	**-.467****	.037	-.075	-.193	—	—								
IIP32 Cold/ Distant mean score (C/D)	.241	-.161	**-.537****	-.203	-.242	.084	-.342	—	—	—							
IIP32 Socially Inhibited mean score (SI)	-.162	.019	**-.429****	**-.432***	-.114	-.122	-.358	—	—	—	—						
IIP32 Nonassertive mean score (NA)	-.139	.096	**-.363***	**-.533****	-.047	-.134	-.215	—	—	—	—	—					
IIP32 Overly Accommodating mean score (OA)	-.041	.340	-.158	-.331	.274	-.065	.055	—	—	—	—	—	—				
IIP32 Self-Sacrificing mean score (SS)	.176	**.412***	.102	-.034	.164	-.118	.282	—	—	—	—	—	—	—			
IIP32 Intrusive/Needy mean score (I/N)	.081	**.490****	.086	-.308	.260	-.354	.242	—	—	—	—	—	—	—	—		
IIP-32 Total mean score	.169	.360	-.339	**-.451***	.087	-.254	-.049	—	—	—	—	—	—	—	—	—	
IAT Total mean score	.158	**.584***	-.015	-.194	-.104	-.218	.042	.104	.301	-.001	.224	.327	**.397***	**.554****	**.526****	**.491****	—

Note- * Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).

Table 2 shows results at Spearman's Rho rank correlation between the number of blogs owned and frequented by participants (i.e., Blog Usage), PI mean averaged scores, IIP32 mean averaged scores and IAT mean averaged scores.
Results showed significant positive correlations between Blog Usage/Openness to Experience (*Rho*=.45; p<.05); Blog Usage/IIP32 Vindictive/ Self-centered (*Rho*=.45; p<.05); Blog Usage/ IIP32 Self-Sacrificing (*Rho*=.41; p<.05); Blog Usage/IIP32 Intrusive/Needy (*Rho*=.49; p<.01) and Blog Usage/IAT (*Rho*=.58; p<.05). Intercorrelations between mean averaged scores on Big Five PI and mean averaged scores on IIP-32 subscales and on IAT have also emerged. In particular, significant negative correlations were noted between Extraversion/IIP32 Cold/Distant (*Rho*=-.53; p<.01); Extraversion/IIP32 Socially Inhibited (*Rho*=-.42; p<.01) and Extraversion/ IIP32 Nonassertive (*Rho*=-.36; p<.05). Similarly, results showed significant negative correlations between Emotional Stability/IIP32 Vindictive-Self-centered (*Rho*=-.46; p<.01); Emotional Stability/ IIP32 Socially Inhibited (*Rho*=-.43; p<.05); Emotional Stability/IIP32 Nonassertive (*Rho*=-.53; p<.01) and Emotional Stability/IIP32 total score (*Rho*=-.45; p<.05). On the contrary, significant positive correlations were found between IAT/ IIP32 Overly Accommodating (*Rho*=.39; p<.05); IAT/IIP32 Self-sacrificing (*Rho*=.55; p<.01); IAT/ IIP32 Intrusive-needy (*Rho*=.52; p<.01) as well as IAT/IIP32 total score (*Rho*=.49; p<.01).

Discussion and Conclusion

Big Five PI average scores obtained by Italian bloggers showed that no specific personality patterns lead people to become bloggers. In regards the associations between blog usage, personality factors and interpersonal relationships quality, our findings suggest that Italian bloggers who own almost one blog and frequent usually three blogs of other people are individuals considerably open to experience and able of managing social relationships. In particular, Italian bloggers describe themselves as not controlling people and affirm to be not excessively affiliative but interested to create "kind," "forgiving" and "sympathetic" social relationships. Such outcomes are coherent with the opinion that blogs represent new and interesting self-disclosure online spaces (Blood, 2002; Miura & Yamashita, 2007). Furthermore, as demonstrated by results regarding the positive correlation Blog usage/IAT as well as IAT/IIP32, Italian bloggers exhibit low levels of involvement in pathological relationships and Internet Addiction.
In conclusion, the present study allowed us to give a picture of some aspects of personality and interpersonal relationships quality of Italian bloggers. We retain that these results confirm the psychological relevance of blogging. People use blogs to disclose themselves having in mind both their private and public declinations. Studying bloggers on their blogs, allowed to explore their looking-glass Selves (Stern, 2007) and to depict their individual characteristics in a true connective environment. However, considering that this is a pilot study, we are aware that further research is needed to better understand blogging – i.e., a new form of *personality in action*.

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Presence, immersion and cybersickness assessment through a test anxiety virtual environment

Gamito, P., Oliveira, J., Santos, P., Morais, D., Saraiva, T., Pombal, M &, Mota, B

Universidade Lusófona de Humanidades e Tecnologias, Lisbon, Portugal

pedro.gamito@sapo.pt

Abstract: *The main goal of this study was to evaluate immersion, along with presence and cybersickness, in a virtual test examination scenario. Sample consisted of 46 students (M = 22.96 years; SD = 5.04), with 12 men and 34 women that were exposed to a test anxiety virtual situation. The experimental setup consisted in 2 PCs, one for psychophysiological recording and the other for VR presentation with a Cybermind HiRes800 HMD. The virtual environment was a test situation in classroom with a teacher and some colleague students. During the virtual exam the participant had to mark the right answer to each question. Besides psychophysiological recordings, data was assessed by ITQ-F (Bouchard et al, 2002), PQ-F (Bouchard et al, 2002), SSQ-F (Robillard et al, 2003), RT (Sarason, 1984), STAI (Spielberger et al, 1983). The statistical analysis was performed through one sample t test, one way ANOVA's and multivariate ANOVA's. The descriptive analysis with the normative data of previous studies revealed an increase in the level of cybersickness and a lower level of presence. However, for immersion higher values were registered when compared to normative data reported in literature. Between genders was observed significant statistical differences for BPM ($F(1;41) = 11.05$; $p < .01$), with higher levels of psychophysiological activation for women. The same analysis revealed significant statistical differences for Immersion ($F(1;44) = 8.99$; $p < .01$) and Presence ($F(1;39) = 6.45$; $p < .05$), indicating higher scores for men. The psychophysiological parameter (BPM) was influenced also by the subject's computer experience ($F(3;39) = 4.19$; $p < .05$) indicating more activation for subjects with less experience. A comparison between frequency of playing computer games also results in a significant increase in Immersion ($F(3;40) = 4.55$; $p < .01$).*

Introduction

Since its outburst, virtual reality (VR) has been used in different areas of application such as simulation, historic reproduction, therapy and training, among others. Immersion and presence seem to be the keynotes of VR. On contrary of others, media of presentation like TV (2D) or IMAX cinema (3D), VR may enable a full immersion of the user with the displayed world. This means that VR can promote a "psychological state characterized by the perception of being included or in interaction with the VR environment" (Witmer & Singer, 1998).

Furthermore, particularly in high meaningfully setups, VR is able to elude one's cognitive system and produce sense of being physically present in the VR world (Slater et al., 1994). This "sense of being there" is also known as presence. (Schuemie & van der Mast, 1999).

Presence is, therefore, considered as a paramount factor when using VR environments, especially considering clinical settings, since it gives an indication of whereas the VR scenario has the ability to drain the subject into it. In this way, the level of presence is fundamental to understand the extension of which the subject perceives the scenario as a real world experience, even though the origin and nature of this variable is still not clear. Nevertheless, Baumgartner, Valko, Esslen and Jäncke (2006) hypothesize that spatial presence derives from the activation of spatial processing areas such as the intraparietal sulcus and its surrounding regions in the parietal cortex.

Virtual Reality has increased its role in the last few years as a tool for treating most anxiety disorders. VR exposure (VRE) as a substitution or a complement of exposure in vivo (EV) and of exposure in imagination (EI) has successfully been applied to the treatment of several phobia and PTSD (Rothbaum et al, 1999; Riva et al, 2001; Emmelkamp, et al, 2002; Botella et al, 2000; Wiederhold et al, 2002, Gamito at al, 2006, Saraiva et al, 2007). According to North, North, & Coble (1996), Riva, Wierderhold, & Molinari (1998) and Rothbaum & Hodges (2002), VRE's main advantages range from increased control

and security to minimization of avoidance and, even, to reduction of costs.

However, there are some areas that are yet to be explored. Test anxiety is one of those . Therefore, this paper describes the use of a VR academic test simulation environment in which subjects were asked to undertake the evaluation as if it was a real life assessment.

Test anxiety is a specific form that belongs to the broad spectrum of anxiety disorders. The anxious state is characterized by an excessive level of fear, apprehension and worrying (Mcdonald, 2001). Students usually perceive the evaluation environment as menacing, feeling therefore vulnerable, having, in the majority of cases, doubts over there own abilities to cope with the identified threat (Beck, 1987). Spielberger (1983) characterizes subjects with test anxiety as individuals with depreciative attitudes and negative expectations about themselves. For Beck (1987), individuals with higher levels of test anxiety would also display higher levels of physiological activation, a distinct feeling of inadequacy and inability to action, low self-esteem, which often results in a strong belief of possible failure.

Apart from the advantages of VRE over traditional exposure techniques, there are also some well-documented setbacks on the use of VR. The most relevant of those is called cybersickness , a natural physiological response to unusual stimuli, which results from an asynchrony between visual, vestibular and proprioceptive information (Stanney, et al. 2002). By moving the head during a VR simulation with a HMD (Head Mounted Display), the sensation of movement that is produced by subject's inner hear is some milliseconds desynchronized with the movement generated by the computer graphic board. This means that when subjects 'sees' movement on the screen the information of it was already sent out to the brain by the inner hear. The subsequent incongruence may produce nausea, headaches, spatial disorientation and vomits. According to LaViola (2000) the cause of this discrepancy resides on the precision of tracking devices (in the case of HMD) and on the reduced frame rate of screens. Cybersickness is a common result of VR exposure, with 50 to 100% of subjects suffering from some sort of discomfort, and 20% to 60% of subjects experiencing abdominal symptoms (Lawson et al., 2002). For Kennedy, Lane, Berbaum & Lilienthal (1993), the secondary effects of VR exposure can be divided in 3 different categories: (1) ocular problems (eye fatigue, blurred vision and headaches); (2) disorientation (unbalance) and (3) nausea (vomit, dizziness). Recent study from Robillard & Bouchard (2007) has shed some light over the subject. 18 subjects severely affected by cybersickness were selected. The results indicate that phobic subjects and women suffer more severe symptoms of cybersickness, as well as a significant positive relation between immersion and cybersickness. Scibora et al (2007), concluded, in a different study, that frequent videogame players presented lesser levels of cybersickness.

Method

Participants
The sample consisted in 46 undergraduate students form Lisbon, Portugal, with 12 men (M = 22.5; SD = 2.96 years) and 34 women (M = 23.21; SD = 5.61 years). The majority of the participants was Portuguese (84.8%) and were Psychology students in University Lusofona of Humanities and Technologies.

Measures
Immersion, presence and cybersickness were assessed using the following questionnaires:

- The Immersive Tendencies Questionnaire – ITQ-F (Bouchard, Robillard & Renaud, 2002);
- The Presence Questionnaire – PQ-F (Bouchard et al., 2002);.
- The Simulator Sickness Questionnaire SSQ-F (Robillard et al., 2003);.
- Test anxiety was assessed through: the Reactions to Tests Questionnaire – RT (Sarason, 1984).
- Anxiety was evaluated through:
- State and Trait Anxiety Inventory – STAI-Y (Spielberger, Gorsuch, Lushene, Vagg & Jacobs, 1983).

Participants' galvanic skin response (GSR) and heart rate were recorded by AcqKnowledge from Biopac Systems, Inc.

Procedure
The study took place at the Experimental Psychology Laboratory in the Faculty of Psychology in University Lusofona of Humanities and Technologies.

The experimental setup consisted in 2 PCs, one for psychophysiological recording by a MP100

Figure 1: VR test anxiety world.

Biopac System and the other for VR presentation with a Cybermind HiRes800 HMD plugged to a P4 3.4 GHz with a 7800 GT graphic board.

Before VR exposure, electrocardiography (ECG) and Galvanic Skin Response (GSR) electrodes where put in place.

The projected VR world was developed using Valve Graphic Editor "Hammer" and rendered by the Source Engine and consisted on a virtual test situation in classroom with a teacher and some colleague students. During the virtual exam the participant had to mark the right answer to each question (Figure1).

Statistical analysis was carried out using the Statistical Package for Social Sciences (v.15.0). The statistical analysis was performed through descriptive statistics to evaluate the levels of immersion, presence and cybersickness, and through one way ANOVA's and multivariate

	This study			Normative data from clinical sample (Bouchard et al. 2002)			Normative data from non-clinical sample (Robillard et al. 2003)	
	M	SD		M	SD		M	SD
Presence								
Realism	27.75	6.94		35.9	5.0		28.9	5.5
Affordance to act	15.75	4.23		21.3	2.6		22.2	4.6
Quality of interface	10.33	3.08		16.0	2.6		16.2	3.0
Affordance to examine	12.48	2.63		17.2	2.6		15.7	2.1
Self assessment of performance	8.74	2.98		11.4	1.9		11.5	2.1
Total	76.20	14.36		102.70	9.70		93.70	11.12
Immersion								
Focus	24.51	4.07		25.7	4.4		24.2	5.3
Involvement	20.24	4.10		16.4	5.5		12.2	4.8
Emotions	14.30	4.52		16.4	3.5		10.8	5.1
Games	7.96	3.20		6.1	2.6		5.6	2.1
Total	67.05	13.16		68.10	11.30		57.70	11.00
Cybersickness								
Nausea	27.75	6.94		16.9	14.7		8.1	12.8
Oculomotor	15.75	4.23		23.3	17.9		16.3	17.7
Disorientation	10.33	3.08		27.8	29.0		20.3	25.2
Total	32.43	10.42		26.10	17.70		16.70	17.00

Table 1 Comparative average and standard deviation scores for Presence, Immersion and Cybersickness.

ANOVA's for comparative analysis.

Results

Descriptive statistics were used to analyse average scores of state and trait anxiety and compare them to normative data from Lam, Michalak and Swinson (2005). According to Lam et al. (2005) cohorts, in this study were observed lower scores on state and trait anxiety subjective measures.

The levels of presence, immersion and cybersickness were compared to normative data reported in previous studies with both clinical (Bouchard et al. (2002)) and non-clinical (Robillard et al. (2003)) samples (Table 1). On both clinical and non-clinical samples, presence scores were higher, whereas cybersickness values were lower. Immersion was reported higher, when comparing to other non-clinical samples.

Used for a comparative analysis between genders, Multivariate ANOVA showed a significant statistical effect for the Reactions to Tests scale (*Wilks* λ (4;41) = .687; $F(4;41) = 4.667$; $p < .01$), namely on Test Irrelevant Thinking ($F(1;45) = 8.454$; $p < .01$) and Tension ($F(1;45) = 4.139$; $p < .05$). The descriptive analysis by average scores on both subscales indicated that men presented higher scores for Test Irrelevant Thinking

	Male		Female		
	M	SD	M	SD	*F*
Test anxiety					
Irrelevant Thinking	2.50	.824	1.84	.628	8.454**
Tension	1.93	.573	2.38	.697	4.139*
Worries	2.11	.558	2.20	.597	.181
Somatic Symptoms	1.45	.443	1.71	.657	.632
Presence					
Realism	32.16	7.030	26.34	6.477	6.530*
Affordance to act	18.66	4.774	14.83	3.596	7.961**
Quality of interface	9.50	3.118	10.72	3.081	1.331
Affordance to examine	13.33	2.606	12.66	2.47	.621
Self assessment of performance	10.83	3.538	8.20	2.484	7.356**
Immersion					
Focus	25.18	.708	24.39	3.912	.302
Involvement	20.91	6.057	20.09	4.63	.221
Emotions	11.09	3.96	15.36	4.365	8.252*
Games	10.27	3.72	7.06	2.57	10.213*
Cybersickness					
Nausea	15.61	23.859	24.57	24.442	1.122
Oculomotor	27.56	20.416	48.47	37.276	3.113
Disorientation	17.72	23.368	40.49	48.265	2.247
Psychophysiology					
BPM	71.39	9.902	83.87	11.000	11.05**
GSR	-2.41	.373	-2.23	.245	3.45

* p<.05; ** p<.01; *** p<.001

and women for Tension.

For Virtual Reality variables, multivariate ANOVA revealed a significant statistical effect for Immersion (*Wilks λ* (4;38) = .530; *F*(4;38) = 8.436; *p* < .001) and for Presence (*Wilks λ* (4;38) = .730; *F*(4;38) = 3.511; *p* < .05).

For Immersion subscales, the tests between subjects indicated significant statistical differences between genders for Emotions (*F*(1;42) = 8.174 ; *p* < .01)and Games (*F*(1;42) = 8.378; *p* < .01), indicating higher scores for men in Gaming and for women in Emotions.

Tests between subjects for Presence subscales showed significant statistical differences between genders only for Realism (*F*(1;42) = 6.711; *p* <.05), Affordance to Act (*F*(42) = 8.751; *p* <.01) and Self assessment of performance (*F*(1;42) = 8.637; *p* <.01), with higher scores for men.

The same between subjects analysis revealed significant statistical differences for psychophysiological data, namely on BPM (*F*(1;41) = 11.048; *p* < .01) and GSR (*F*(1;43) = 5.482; *p* <.05), with higher levels of psychophysiological activation for women.

The psychophysiological parameter (BPM) was influenced also by the subject's computer experience (*F*(3;39) = 4.186; *p* < .05) indicating more activation for subjects with less experience, nevertheless no significant statistical differences were observed between subject's computer experience for immersion, presence and cybersickness (Table 2).

A comparison between frequency of playing computer games also results in a statistically significant effect on Immersion (*Wilks λ* (12;98.184) = .465; *F*(38) = 2.744; *p* < .01), but only on Gaming subscale (*F*(3;43) = 12.568; *p* < .001), demonstrating higher scores for participants with more computer game experience.

Discussion

Participants' perception of being included, or in interaction, with the VR environment seemed to be achieved in this study. Values for immersion were significant higher than the ones reported in other studies (Bouchard et al. 2002; Robillard et al. 2007). In this way, this VR scenario is probably fitted to be used on a clinical population in order to investigate its ability to treat patients with test anxiety. Further studies on clinical populations are therefore required.

Meaningfulness, which according to several authors (Witmer, & Singer, 1998; Hoffman, Prothero, Wells, & Groen, 1998).) is a chief cornerstone of presence was, probably, not attained in this study. Actually, participants reported

Table 2. Effect of computer experience groups in BPM

	None			Basic			Intermediate			Specialist		
	M	SD		M	SD		M	SD		M	SD	*F*
BPM	91.10	0.00		87.55	7.91		76.43	12.38		71.58	8.67	4.186**
GSR	-2.42	0.00		-2.29	0.29		-2.40	0.63		-2.14	0.15	.272

* p<.05; ** p<.01; *** p<.001

Table 3. Effect of playing computer games in Immersion

	None			Basic			Intermediate			Specialist		
	M	SD		M	SD		M	SD		M	SD	*F*
BPM	91.10	0.00		87.55	7.91		76.43	12.38		71.58	8.67	4.186**
GSR	-2.42	0.00		-2.29	0.29		-2.40	0.63		-2.14	0.15	.272

* p<.05; ** p<.01; *** p<.001

lower scores of state and trait anxiety when compared to normative data from Lam et al. (2005). This difference may result from participants' perception that the task was not a real life test, at least for state anxiety. In fact, though they had to fill in a questionnaire on Portuguese culture, they knew from the start that it was not a real exam. Being not a clinical population other results would not be expected. The studies (Bouchard et al. 2002) that were elected for comparison, in which higher presence was reported, were conducted on clinical samples. When compared to clinical populations, non-clinical populations reveal lower levels of presence (Robillard et al, 2003). Cybersickness may as well had its share of accountability on the relative lower levels of reported presence. In fact, cybersickness has a negative effect on presence (Witmer & Singer, 1998).

All three constructs (presence, immersion and cybersickness) seem to be influenced by individual traits such as gender or age (Bouchard et al, 2006). Furthermore, proficiency in using personal computers and playing video games appear to improve the experience of immersion. In fact, concerning immersion subjective measures, women rated more immersion due to emotions in the virtual exposure and men due to gaming related conditions within virtual exposure. These data are in agreement with self-reports measures for presence, which also indicate significantly higher presence in men, in particular for the possibility to react and performance evaluation dimensions. Indeed, the great majority of men that report playing video games may have contributed to this gap between genders, and resulted in a more efficient interaction with computer and, consequently, with the virtual environment (Gamito, 2007).

The psychophysiological measures, beats-per-minute (BPM) and galvanic skin response (GSR) showed more physiological activation in women during VR exposure which could indicate that women were more anxious to the virtual exposure than men. This could be the result of a lack of interactivity within the virtual environment. In agreement with this data, BPM was also influenced by subject's computer experience, with higher levels of psychophysiological activation for the participants with less experience in video games. Furthermore, immersion was also influenced by the subject's frequency of playing computer games, indicating higher perception of immersion for subjects that played more computer games.

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The implementation of graphic mode phoneme learning system for hearing impaired

Yun-Long Lay [1] Justin S. Lay[2] Hui-Jen Yang [3]

[1] Professor, Department of Electronic, National Chin-Yi University of Technology, Taiwan
yllay@ncut.edu.tw
[2] Undergraduate, Department of Computer Science and Information Engineering, Tunghai University, Taiwan
s942844@thu.edu.tw
[3] Professor, Department of Information Management, National Chin-Yi University of Technology, Taiwan
yanghj@ncut.edu.tw

Abstract: *In general, language training needs a professional instrument to analyze speech for supporting the pronunciation of hearing-impaired people. However, non-professional speech spectrum equipment is very expensive and its output is not easy for hearing-impaired people to understand and learn. The purpose of this research is to propose a graphic mode displaying system (GMDS) to support the speech learning for hearing-impaired people at low cost and better learning performance. The components of GMDS include a computer connecteds to a microphone as input device to capture the speech features; a neural network is used to extract the features for speech recognition; a needle pointer graph displays the voice message on the screen to support the hearing-impaired people to learn speech. A system usage evaluation of GMDS was performed after the system was implemented.*

Keywords: *needle pointer graph；hearing impaired；Neural network*

Introduction

Hearing ability is based on the onset of hearing loss and can be divided into congenital inheritance and afterward occurred. If the hearing ability occurred afterwards, then the hearing-impaired people still possess language ability, but they can not clearly hear what people say. If the hearing-impairment is a congenital inheritance, they would have hard time to learn speech. According to the Critical Period Hypothesis (CPH), children have an ideal period to learn speech and language. The best time of language learning is from age 8 to age 12 (Newport, E. L., 1991). Thus, the hindrance of hearing and language will affect individual's learning performance and recognition. If hearing-impaired people can not receive a good language training and be guided properly, they can not communicate with people. This will cause constrains for hearing impaired people to find some kind of jobs. Based on the statistical data, one of one-thousand newborn babies is suffering from the Congenital Hearing Handicap, which has much relation to recessive inheritance. Hearing-impaired people are not completely deaf and still have some residual hearing. They can not use their own auditory ability or hearing-aid devices to monitor their pronunciation correctly. Language learning of hearing-impaired people depends on their feeling or guesses to determine the pronunciation, so they can not pronounce properly and correctly. Currently there is no effective method or tool to prevent and remedy hearing loss. Therefore, implementing a computer-aided learning system to improve their language learning and training is an effective and convenient method.

The graphic mode displaying system (GMDS) for speech learning, implemented in this study is suitable for hearing-impaired students to learn Chinese pronunciation. The system includes a computer with graphic-display screen and microphone to increase the learning performance for hearing-impaired students.

System Framework

Speech recognition initially should extract the speech features to establish the speech feature database for neural network training data (L. R.

Rabiner and Juang B. H. 1993). A three- layer Back propagation neural network and Self-Organizing Maps (SOM) are applied in this system. BPN is used to recognize the speech and SOM is used to create the needle pointer graph. The speech features database is separately delivered to BPN and SOM for training. BPN gets the adjusted weighting values and SOM obtains the speech features. The trained weighting values are then delivered to BPN as a testing recognition reference. The two-dimensional topology is transferred into the needle pointer graph coordinates distribution graph. When the user operates the system, a microphone is used to input the speech signal and then the software extracts the speech features and sends them to BPN for recognition. The result is displayed in the needle pointer graph. The system framework is shown in Fig.1.

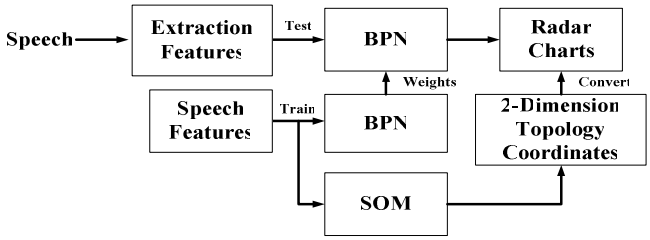

Fig.1 Framework of the graphic speech

Feature extraction

During the speech recognition process, speech recognition extraction is the first step to develop the speech feature database as a neural-network training database. An efficient method to represent the appropriate feature parameters is necessary to process the speech data. The obtained feature parameters will indirectly affect the speech recognition rate, through the sampling process speech signals are extracted from soundcard inside the PC. The sampling rate of the system is 8 K/sec. The resolution is 8 bits, which means the speech signal waveform is 8000 dots per second. The extraction of speech features must go through some complicated processes. The sampling process initially goes through the starting-point and the ending-point to detect the start and end position of speech. The speech signal interval is every 15 ms to construct the sound-frame, following with the procedures including Endpoint detection, Segmentation, Pre-emphasize, Hamming window, Autocorrelation, LPC analysis and Cepstrum to get the speech feature coefficients (Pramod B., 1998). The size of speech data is very large and can not be stored as the reference sample for speech recognition. The speech features parameter is replaced by Cepstrum coefficients.

Linear Prediction Code (LPC) analysis

LPC analysis decreases the errors of actual and predicted speech signals. The method is to measure the pitch period and resonance frequency and gets the useful speech parameters quickly.

(1)

$$S(n) = \sum_{k=1}^{p} \alpha_k S(n-k) + GU(n)$$

where U_n is a digital filter, G is the digital filter amplitude gain, p is the LPC prediction order and α_k is the LPC coefficients.

Cepstrum

Cepstrum is a method to convert the speech signal spectrum characteristics from the detailed varietion and peaks of the waves. The peaks of a speech signal's wave appear in the low Cepstrum and the detailed varietion appear in the high Cepstrum. Equation 2 is the Cepstrun coefficient.

(2)

$$C(\tau) = F^{-1}\log|X(k)| = \frac{1}{N}\sum_{k=0}^{N-1}\log|X(k)|e^{j\frac{2\pi kn}{N}}, 0 \le n \le N-1$$

where N is the Cepstrum coefficients and $X(k)$ is the speech signal.

Cepstrum coefficients have the characteristics of a discrete pronunciation voice box model and simulating signal to precisely calculate the vocal parameters. The obtained effective speech parameters can be applied in the speech recognition.

Neural Network

An artificial neural network is one kind of simulation of human biological-type systems. The neural network (NN) is an interconnected group of artificial neurons. The advantages of NN are high-speed computing, large memory, high learning ability and high error-tolerance. The types of NN's learning method can be divided into supervised and unsupervised learning network. Supervised neural-networks are applied in the classification, prediction and recognition. The unsupervised neural-networks are mostly applied in the clustering (J. M. Zurada, 1992).

Self-Organizing Map

Self-Organizing Map (SOM) is an unsupervised learning network. The input is the series of values. The fundamental principle of SOM is to learn the Clustering rules and apply them to the testing samples from the training samples. SOM consists of input layer X_i and output layer Y_j

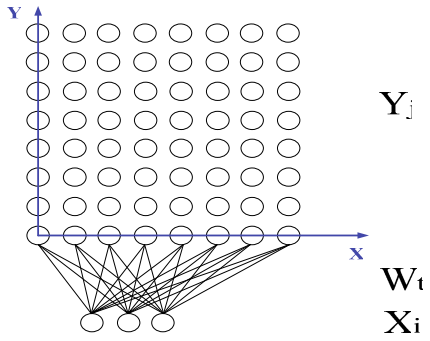

Fig 2. Self-Organizing Maps structure

The algorithm of SOM applies the Euclidean distance to calculate the output unit and network j topology and distance from the center. Eq.(3) D_j is to calculate the Euclidean distance of (X_j , Y_j) to C on the coordinate diagram (Linske R. 1988).

(3)

$$D_j = \sqrt{(X_j - C_x)^2 - (Y_j - C_y)^2}$$

where (X_j , Y_j) are output j topology coordinates and C is the center of the topology coordinates.

The Mandarin phonetic signal distribution on the needle pointer graph is using the cluster feature of the Self-Organizing Map (SOM) neural network. SOM calculates the Euclidean distance of all of the Mandarin phonetic signals between each other and signals with similar characteristics move closer together. The similar Mandarin phonetic symbols cluster on the needle pointer graph. Each Mandarin phonetic symbol selects 20 features in the Self-Organizing Map and trains 1000 times. The result shows on the corresponding position on the needle pointer graph. In Eq. (3), D_j is to calculate the Euclidean distance of N to M on the coordinate diagram.

Training

When the network begins to learn, the first step must set the network parameters, the input vector X , the hidden number H , the output vector Y , the learning cycle, and the learning rate η . The Network randomly produces the weighting values including the input layer to the hidden layer Wxh_{ih} , the hidden layer to output layer Why_{hj} , the hidden layer's bias θh_h and the output layer's bias θy_j .

Testing

When BPN is testing, all Cepstrum coefficient data is delivered into the network and starts the iteration by the training data of Why_{hj} , θh_h ,

θy_j , and Wxh_{ih} . The neural network is based on the connected weight and bias to adjust the construction from testing data to get the target vector T .

Eq. (4) is inserted into Eq. (5) to get the hidden layer vector H .

(4)

$$net_h = \sum_i Wxh_{ih} X_i - \theta h_h$$

(5)

$$H_h = f(net_h) = \frac{1}{1+e^{-net_h}}$$

Eq. (6) is inserted into Eq. (7) to get the input layer X to target vector T

(6)

$$net_k = \sum_h Wht_{hk} H_h - \theta t_k$$

(7)

$$T_k = f(net_k) = \frac{1}{1+e^{-net_k}}$$

Needle Pointer Graph

After the SOM training of the speech features, the network distributes every Mandarin phonetic symbol's signal on a 2-dimensional coordinate. The topology coordinate is an 8x8 2-dimensional array. Then, set the origin at (4,4) to get Mandarin phonetic symbols with radius 4 as shown in Figure 5. The distance between each Mandarin phonetic symbol represents their similarity. The greater the similarity of the pronunciations, the closer the coordinates on the needle pointer graph will be. This is the cluster characteristic of SOM.

(8)

$$Rx = X * 26.52$$

(9)

$$Ry = Y * 26.52$$

Radius unit length of the needle pointer graph is 150 with the equation of isosceles right triangles. An isosceles right triangle with two-equal sides, and their corresponding angles are 45°. The triangle length ratio is $1:1:\sqrt{2}$ to get the radius unit length of 2-dimensional coordinates with length 106 units. The coordinate axis of needle pointer graphs of each scale is 26.52 units length which is one-forth of the axis length as shown in Fig. 3.

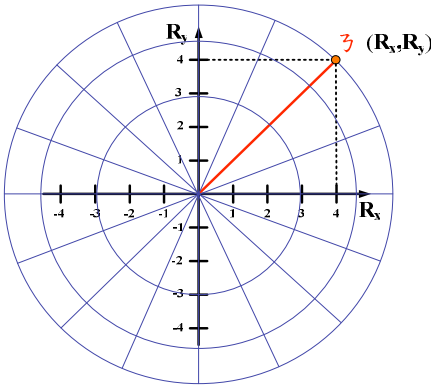

Fig. 3 2-dimensional coordinates converting to the needle pointer graph

The results of each needle pointer graph is calculated from SOM training speech features. Each Mandarin symbol alphabet extracts 20 data features as training data. Through 1000-iteration training cycles, 2-dimensional coordinates are obtained.

Experiment Results

This system is using BPN as the framework of speech recognition. Choosing the practice button of a phoneme signal on the operating interface, the computer screen shows the right position of the phoneme signal. Pressing the REC button starts the user's recording by microphone and the data is shown in the Speech Waveform window. When the speech waveform window shows the user's extracted speech, pressing the EXTRACT button converts the speech into its features. After finishing the last step, pressing the RECOGNITION button applies the BPN recognition test's speech. In final, pressing the SCORE button shows the recognition results on needle pointer graph window, compare to the database.

The tester using the microphone emits the appro-

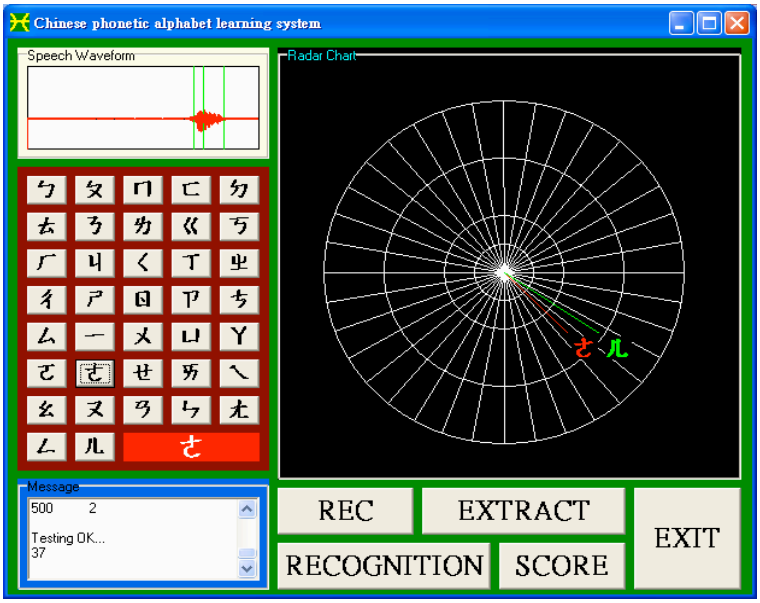

Fig. 4 **The implementation of the graphic-displaying speech learning system**

priate phoneme signal. The red line on the needle pointer graph is the mark of the corrected pronunciation. The green line is the user's mark of the testing pronunciation. When the pronunciation is correct, the two lines overlap. If the pronunciation is not correct, the two lines are separated. The distance between the two lines is the reference to adjust the pronunciation. The system calculates the corrected pronunciation and similarity of the test and then the score is displayed on the screen, shown in Fig. 4.

20 features from each phoneme were extracted for training in BPN. Through the adjustment of the experimental process, each phoneme trains 1000 times. After the adjusted weighting value, the recognition rate is appropriated. The recognition accuracy rates are shown in Table 1. The accuracy rate over 80% is good enough for hearing impaired to learn the phoneme pronunciation. All of the remaining phonemes under 80% recognition rates should not be used as the learning sets. Those low recognition rate phonemes are caused by the similarity in features which need more study to resolve.

Accuracy rate	Chinese phonetic alphabet
	ㄇㄈㄑㄒㄔㄖㄙㄨㄚㄛㄝㄞㄢㄤㄦ
	ㄐㄧㄩㄣ
	ㄎㄗㄘㄜㄟㄡ
	ㄅㄆㄉㄊㄌㄍㄏㄓㄕ
	72%

Table 1. Mandarin phonetic alphabet recognition rate

Conclusion

The RDS improves the traditional language training method using needle pointer graph to increase the hearing impaired's learning performance. When the hearing impaired start to learn languages, they can not judge whether their pronunciation is correct or not and then indirectly cause learning obstacles and decrease their learning intention. In general, The hearing impaired use assistive devices and special teaching methods to increase their learning efficiency.

This system can help hearing-impaired people build up their speech learning foundation and reduce their language learning problems. However, owing to the characteristics of sound vari-

ability, speech is easily to be affected by external noise. This is why it is hard to get the optimal recognition rate. How to increase the recognition rate is a major technical problem. For advanced study, the recognition rate is one of the major issues to overcome in pronunciation, spelling, vocabulary, phrase and grammar to build up a comprehensive language learning system.

Acknowledgement

The author would like to thank that this work was supported by the National Science Council of Taiwan, ROC under Grant No. NSC-96-2221-E-167-026-MY3.

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How ethically we practicing online: an exploration of potential online provider liability

Kristie Holmes- Union University, Ph.D Candidate

Little attention has been given to liability issues and practitioner vulnerability in the rapidly emerging modality of online therapy. The purpose of this recently completed study is to explore the ethical issues faced by mental health professionals practicing in the online modality. Participants were online mental health professionals, both male and female that hold a minimum of a master's degree. Practitioners completed the Online Therapy Practices Inventory in order to gather exploratory data on their every day practice, perceptions of their own ethical practice, and areas of possible liability. The International Society for Mental Health Online (ISMHO) Suggested Principles for the Online Provision of Mental Health Services was used as a framework for gathering data. Ethical practice and procedure of clinicians, as well as ethical issues encountered by practitioners were examined through the use of univariate and bivariate descriptive statistics. Data produced from this study will be useful for professional organizations, educational institutions, licensing boards, and practitioners alike.

That it will ever come into general use notwithstanding its value is extremely doubtful…because its hue and character are foreign and opposed to all of our habits and associations…There is something even ludicrous in the picture of a gray physician proudly listening through a long tube applied to the patient's thorax. (Putman, Portnoy & Villapiano as cited in Their, 1988).

What may have previously sounded absurd is now every day practice for medical doctors. If using a stethoscope sounded far fetched in the 1800s, it may reflect how many thought of the practice of online therapy even a decade or two ago. Online therapy also seems farfetched to many in the mental health field even though it has been more than a decade since its inception. However, larger numbers of professionals are exploring this modality of delivery of mental health services. Only recently has attention begun to focus on the ethics of online therapy.

In June of 2007, the first inaugural summit on "behavioral telehealth" took place at Harvard Medical School. The lens of this conference was consumer driven approaches to self care, a reflection of the increasing importance of online therapy as a as a branch of mental health practice (PR Newswire, 2007). The need to determine whether or not online clinicians are currently practicing in ways that may be illegal or unethical, and identifying liability issues that could result in lawsuits against the mental health professional practicing in the online medium was an important focus of the conference. For ethical practice to be mandated, Manahal-Baugus (2001) states that clinicians need to know what is effective for their patients. Yet as Pollock (2005) notes, there are many aspects about the efficacy, advantages, and disadvantages of this method of therapy for which little information is available. He concludes that as technology advances and security increases, so will clients' use of the Internet to seek out services and information. This suggests that comparing the effectiveness of online modalities with the effectiveness of traditional methods would be an important area to explore. But before this type of research should be completed, studies must explore what issues in current practice pose liability or ethical issues.

From this researcher's view, the efficacy of online therapy is determined by the ethics of the practice. Unless there is some consensus among practitioners as to what is or is not ethical in the purpose, delivery, and domain of online therapy, and qualifications and credentials of its providers, there is little to be gained in studies of its effectiveness. In other words, if we are not sure what online therapy is, how can we evaluate its effectiveness? As a first step towards this goal, ethical practices in the online environment that may put online mental health services providers at risk for liability need to be identified and examined, which was the purpose of this exploratory study.

Motivations for Online Therapy

When consumers look for help to assist in life's troubles they do not always turn to traditional psychotherapy to gain insight. Oftentimes consumers will go to their primary care doctors to get

relief from somatic mental health symptoms (Locke, 2007). But now, many are reaching for their laptop or PC, which is often their lifeline to daily matters. As early as the year 1999 a Harris poll found that nearly 100 million adults searched the web for mental health information (CNN, 2007). Consumers are busy and they want services quickly. Why make time every week for a standing appointment when one can vary their treatment with an online relationship? Workforce professionals and students alike are constantly "on the go," nestled in generic hotel rooms across the country. Limited time in a busy client's day may be a key influence that pushes one to reach for the computer keyboard rather than picking up a phone to make an appointment for an in-person session.

Online services may also be sought by clients who are more inclined to write than speak their troubles. Perhaps clients who prefer writing as a means of communication would never seek out in-person treatment but do so online only because the availability for them to communicate in the way most effective for them is alluring. Yet another reason online services might be more attractive to a potential client is that the fear of seeking out mental health services in face to face setting would be removed. The client would not be seen going to and from a designated office and the client may not feel the discomfort of talking to a professional about their personal issues (fear of personal judgment on issues or appearance (Bedrosian, 2007).

Bedrosian (2007) stated that lack of access to care, stigma, and privacy concerns prevent people from reaching out for care when they need it. Online counseling may be a viable option in these instances. For instance, Mallen, Vogel, Rochlen, and Day (2005) suggest that individuals in those small towns where "everyone knows everyone" and who would rather not risk their confidentiality may be well served by online counseling. Online counseling is also well suited for individuals who experience difficulty accessing mental health services because of geographical distances, a barrier faced by those in many small town and rural areas (Crawford, 2006). If there is less shame involved in seeking needed treatment, increased services can be rendered, reducing costs to all involved. When online therapy is seen as a viable alternative to face to face treatment, more people can be reached and treated.

Online services are also attractive to mental health providers as well. Therapists who work in agency or governmental contracts as well as under health maintenance organization restrictions may find the practice of online therapy liberating. A 'burned out" therapist may find the luxury of using theory and their own words in the helping relationship rather than feeling boxed in by predetermined treatment plans that fit the organization's requirements. Not having to "check the appropriate box" for the "approved method" to find a way to fit the concluded session into organizational mandates can be freeing. This type of practice may give the practitioner the feeling of "this is what I spent so many years in school for".

Qualifications, Training, and Scope of Online Practice.

Maheu and Gordon (2000) noted that 90% of the practitioners that completed their questionnaire in a study of the qualifications and practice of online therapists stated that they were licensed in their appropriate state or country to practice psychotherapy and all held at least a Master's Degree in the subject area. Interestingly, although qualifications in the field were high in each state, in another study Mallen and Vogel (2005) observed that 75% of the therapists they surveyed practiced online therapy outside of the state that they were licensed in. Again, if there are not enforceable guidelines to follow, it is difficult to gauge the degree to which an online therapist is practicing ethically or within their scope.

Trepal, Haberstroh, Duffey, and Evans (2007) noted the need for training therapists in the online medium so that practitioners have at least basic online counseling skills available to them. Much commentary has been made in the literature over lack of, or level of training beyond the degree in mental health, including whether practitioners have acquired certification or further training in the area (Plunkett, 2004; Dougan, 2002). However, this question may be irrelevant for online therapy at the present time since there are not supported practices yet endorsed. Currently, there is no required training for the practice of online therapy and no consensus or endorsement from professional organizations or licensure boards of what Continuing Education courses will improve a provider's services, nor is there requirement for certification beyond the required degree and license. Although Trepal, Haberstroh, Duffey and Evans (2007) have recently compiled educational tools to teach master's level counsel-

ing students basic online therapy tools, there are no professional counseling organizations that officially endorse, or enforce any existing online counseling training, let alone address the issue of what constitutes ethical practice.

Online Therapy Domain and Licensure Boundaries

Locke (2007), an attorney specializing in the healthcare industry, notes that regulatory and liability issues are in need of fine tuning. Similar regulatory and liability issues are present in emerging online counseling practice as clinicians in a number of states and members of a variety of professional organizations vie to determine who owns the territory of the world–wide-web. The lack of established laws and guidelines within each state make it difficult for a practitioner to know how to practice online therapy. If there are not enforceable guidelines to follow, or approved training to establish a professional as competent, it is difficult to gauge how ethically an online therapist is practicing (Trepal, Haberstroh, Duffey, & Evans, 2007). Whether or not the client is virtually "coming to the office" in the state where the professional is based or the professional is doing a "house call" in another state or country is a question continually debated in the profession, particularly since training and education requirements can vary from state to state and country to country (Blau, 2007). The geographical boundary issues involved in sanctioning ethical practice of its mental health providers is an area yet to be tackled by governing licensing boards and professional organizations.

The most controversial "legal" issue is territorial state licensure laws. In face to face practice, a clinician must have a license to practice in a particular state. It seems logical that the online practitioner should also be licensed in the state that they practice as well, thereby following all of the laws and ethics of the mental health profession that they are associated with. But what about provision of online services to clients that are not within the state where the professional is licensed, or for that matter, in the same country? As some see it, online therapists are practicing unethically by providing services to clients outside of their licensed state. (Blau, 2007; Attride, 2004; Collie et al., 2002;). Ragusea and Vande-Creek (2003) have pointed out that confusion will continue as long as ethical considerations that are attached to legal questions (that vary from state to state) remain unresolved.

Confidentiality

The confidentiality and security of computer-based records is continually being called into question (Alleman, 2004; Manhal-Bagaus, 2001; Rochlen, Beretvas & Zack, 2004; Skinner & Zack, 2004). At this point in time, it may be that even private traditional practitioners are being pressured to begin using more standardized record-keeping methods for liability reasons, even if there is no third party billing. It may also be that there are very few practitioners left that do not use a computer at all in some way in their mental health practice.

That being said, the moment a patient's records go in to a computer system, there is a risk of a confidentiality or security breach, and no matter how minimal it could become a possible lawsuit. Meticulous, confidential record keeping as a mental health professional is just as serious an issue for online clinicians as it is for those traditional practice. All clinicians, regardless of the therapeutic modality need to be vigilant about protecting client's confidential information, especially when any technology is in use.

Because of the inconsistency, misinformation, and confusion present in ethical standards currently, online therapists must practice due diligence in providing and receiving accurate identifying information on a client. This is not only to protect the client's confidentiality, but to ensure that the professional's records are accurate and represent the person stated. Storage of client information is another area in which clinicians must be vigilant in order to avoid potential liability in the realm of keeping a client's confidence.

Standards for the Provision of Online Therapy

Seeking mental health services online is becoming increasingly common (Chang, 2005; Pollack, 2006), and a literature on the efficacy of online treatment is beginning to emerge (e.g., Stevens, Doidge, Goldbloom, Voore, and Farewell 1999; Marks, Mataix-Cols, Kenwrights, Cameron, Hirsch, and Gega,, 2003 ; Pollack 2006). Nevertheless, even though evidence that online therapy is helpful to clients is emerging, little is yet available from professional organizations that gives clear guidance to professionals on how to deliver services ethically online to avoid liability in their practice (Chester & Glass, 2006).

For instance, the American Psychological Association (APA) has nearly ignored the existence of online practice over the past for the past decade, releasing only a brief statement that provides little guidance for online psychologists. The National Association of Social Workers (NASW) only gives curt warning on its website to its members (NASW, n.d.). With exception of the American Counselors Association (ACA) which has implemented a new code incorporating online therapy as an additional mental health treatment modality, Heinlen (2007) notes that not only APA and NASW but other professional organizations have done little to address the role and standards for online therapy. Most recently the National Board of Certified Counselors (2007) implemented standards for WebCounseling. However, the standards set forth by the ACA and NBCC have not been implemented or acknowledged by the APA, NASW or the like.

The only professional organization that (truly) directs a framework for ethical practice is the International Society for Mental Health Online (ISMHO) in its Principles and Ethics statement, based on ethical practices from United States even though this organization is international. Even with the best intentions, both professional therapists and consumers are hard pressed to translate the myriad of rules and ethical stances in the counseling professions to the online medium. Debates and opinions on ethics and best practices abound in the online therapy literature (Heinlen, 2003; Chang & Chang, 2004; Barnett, 2005; Rochlen, Zack & Speyer; Trepal, Haberstroh, Duffey & Evans, 2007), and clients could be easily confused or misled by those promoting their beliefs whether or not they are supported by research. Furthermore, professionals put their license and livelihood at risk because of the unknowns, leaving them wide open for lawsuits for malpractice, competency issues or inadequate training.

Online therapy is taking place over the medium of the Internet in spite of the lack of input from state licensing boards, professional organizations or professionals about its practice. This study explores liability issues faced by practitioners as they practice in the online environment. Findings from the study can be used by professional organizations as they establish appropriate guidelines that are informed by, and encompass, the unique characteristics of online mental health services.

Specifically, this study explores the extent to which mental health professionals currently practicing online therapy as a modality are following available guidelines for the practice of online therapy, including those outlined in the International Society for Mental Health Online (ISMHO) Principles and Ethics statement. Although ethical guidelines are established by the ISMHO, it was unknown if the guidelines are being implemented in practice, or to what extent. In essence, are the actual every day practices of online mental health professionals minimizing or putting them at risk for lawsuits? Ethical dilemmas encountered by professionals when trying to apply their current ethical code to online practice will be also be explored (what does not work when one applies their code to the online medium?). Other ethical dilemmas will also be identified, including those identified by practitioners and those which put practitioners at risk unawares.

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Author Information:

Kristie Holmes, MSW (University of Southern California) LCSW, Ph.D. Candidate is currently an Assistant Professor of Social Work at Union University and serves on the Board of Directors for ISMHO (International Society for Mental Health Online). She is currently researching the ethical practice of online therapists and previously was involved with research that was investigating an evidence based intervention with children who had been traumatized (CBITS) Cognitive Behavioral Intervention for Trauma in Schools which was funded by NIMH. She has trained MSW interns in the field (clinical practice) and previously held the position of Clinical Director of Mental Health at a non-profit organization in Los Angeles that was partnered with USC, UCLA and Children's Hospital Los Angeles. She specializes in the topics of depression (children and adults) and ethical practice.

Virtual reality gaming for treadmill training: improving functional ambulation in children with cerebral palsy

[1]Karen Kott, [2]Gianluca De Leo, [3]Katrina Lesher, [4]Eleonora Brivio, [5]Steven Morrison

[1]School of Physical Therapy, Old Dominion University
[2]Virginia Modeling Analysis and Simulation Center, Old Dominion University
[3]Physical Medicine and Rehabilitation, Eastern Virginia Medical School
[4]Virginia Modeling Analysis and Simulation Center, Old Dominion University
[5]School of Physical Therapy, Old Dominion University

Abstract: *The purpose of this article is to describe a project where we designed and implemented a virtual reality (VR) game to engage children with cerebral palsy (CP) during treadmill training. For children with CP, the acquisition, refinement and retention of ambulatory skills remains a primary focus of physical therapy programs. The use of the treadmill has been shown to be feasible for these children making an impact on the spatiotemporal parameters of gait after 9 hours of training. To get the children to train for 9 hours, play was suggested as a way to keep them engaged. VR had the potential to provide play in practice on the treadmill. Preliminary results of this project show that all the subjects accepted and enjoyed the VR game, completed the 9 hours of training, and made changes in the function of ambulation.*

Cerebral Palsy (CP) describes a group of permanent neurodevelopment conditions, of a non-progressive nature, that occurs in the fetal or infant brain. A primary effect of this group of motor disorders is on the development of movement and posture with a wide range of clinical presentations causing activity limitation (Rosenbaum, Paneth, Leviton, Goldstein, & Bax, 2007). The clinical presentations could include; increases in muscle tone (spasticity), lack of coordination (ataxia), and involuntary movements (dystonia and athetosis). These may be accompanied by secondary musculoskeletal impairments such as muscle weakness and joint contracture (Rosenbaum, et al., 2007). Together these motor changes can limit any activity or function, often with major implications for walking, a key functional limitation for children with CP. Due to its key status, the ability to ambulate is used to classify these children into one of the five levels of functional mobility or activity limitation of the Gross Motor Function Classification System (GMFCS) (Palisano, Hanna, Rosenbaum, Russell, Walter, Wood, Raina, & Galuppi, 1997)

The importance of the acquisition, refinement and retention of ambulation skills remains a primary focus of physical therapy programs for children with cerebral palsy, not only for the development of initial mobility, but as a focus for lifelong preventative care. It is a constant challenge for both the therapists, who strive to develop appropriate therapeutic activities, and for families, who need to be able to follow through with those activities that are meaningful, challenging and offered in the theory of "best practices" for motor learning (Valvano, 2005). Some of the features of "best practices" for physical therapy intervention include movements that are 1) self-initiated and useful, 2) adaptive to the environment, 3) practiced repetitively, and 4) goal directed. For children with less severe types of CP (GMFCS Level I and II; Palisano et al., 1997), ambulation develops as their primary locomotor skill, but may not be refined or used as a mode of exercise due to a lack of challenges that call for adaptations to occur. For children with more severe types of CP (GMFCS Levels III and IV) ambulation is often developed, but it is always limited and often not retained. Bell and colleagues (2002) demonstrated that ambulation function in individuals with CP deteriorates over time. This can begin in some children as early as 7 years of age. This loss/limitation to ambulation skill often requires these individuals to use wheelchairs for mobility. Day and colleagues (2007) predicted that individuals with CP had a 34% chance of becoming non-ambulatory if they stop walking and use a wheelchair. In contrast, individuals who retained ambulation, even if difficult, only had an 11% chance of becoming non-ambulatory. This study also demonstrated that those who become non-ambulatory have a greater chance of earlier death (6%).

Use of the treadmill for locomotion training has

been shown to be feasible for children with CP, producing notable changes in spatiotemporal gait parameters (Richard, Malouin, Dumas, Marcoux, Lepage, & Menier, 1997). The treadmill requires the child to initiate movement to maintain gait, allows for repetitive practice of walking motor patterns and can be adjusted so as to require the child to adapt to environmental changes of speed and incline. One limitation of this device is that it is not often seen by children as a functional activity; it often appears more like work. Another limitation is the amount of training time required to impact on gait parameters (e.g., step length, walking speed). Previous studies have shown that, in order to effect changes in the parameters of gait in children with CP, each child had to train on the treadmill from 9 to 10 hours (Richards et al., 1997).

The perceived tedium of treadmill walking may not be stimulating enough to keep a child interested in walking long enough to make a significant impact upon the various parameters of gait/ function of walking. The challenge therefore is to make gait training meaningful and challenging to a child. Play is meaningful activity to children and it is a common way they learn to move and interact. Incorporation of play and play techniques is recommended as a way to provide meaningful rehabilitation interventions for children (Rodgers & Ziviani, 1999). Children without CP play easily, using play to learn and refine functional ambulation skills. Children with CP often need more guidance to learn and refine functional ambulation and the interventions to develop functional ambulation may be more meaningful in the context of play. Arguably, this is an element that may have been missing from many traditional training studies.

Virtual reality (VR) refers to the simulation of a real or imagined environment and has the potential to provide this missing element. VR can provide an atmosphere of play through the challenge of a videogame while preserving other “best practices” for motor learning. Grealy and Heffernan (2001) theorized that virtual reality could enhance practice on a physical level because it would make it more meaningful and challenging through stimulation of cognitive, mood, and social interactions. Previous research that created VR environments to afford opportunities to practice tasks by adults with and without neurological disorders suggests that meaningful practice occurs. Few studies have focused upon gait training, but walking in such environments changed spatiotemporal gait parameters that reflected gait stability in healthy adult participants (Hollman, Brey, Robb, Bang, & Kaufman, 2006) and in adults after suffering a stroke (Deutsch, Merians, Adamovich, Poizner, & Burdea, 2004). The results from the series of studies in the adults post-stroke concluded that this technique merits further investigation (ibidem). To date, only one other pilot study has combined virtual reality and gait training for children (Koenig, Wellner, Koneke, Meyer-Heim, Lunenburger & Riener, 2008).

In designing a virtual environment for clinical use, a critical feature should be its ability of inducing meaning and emotions in users (Riva, & Waterworth, 2003). Following this concept, an important way to induce a high level of meaning in a virtual environment could be the system-related features such as graphic realism, level of immersion, and interaction devices as well as the setting of the VR experience within a meaningful narrative context, favoring user identification and involvement.

The purpose of this pilot project was to design, develop, and test the use of a virtual game to help in a rehabilitation program for gait in children with CP. The virtual game was theorized to help the children while walking on the treadmill to stay focused on walking, walk for long enough periods of time to change their function through adaptations to the changes in speed of the treadmill. This paper presents information on the methodology of the intervention, the development of the virtual reality game, and preliminary results from three subjects.

Methods

In this section we present the *Standardized Walking Obstacle Course* (SWOC) a tool that was used for determining functional ambulation of participants before and after the treadmill training, describe the development of the Virtual Reality Game, and provide subjective and objective results from the intervention.

Standardized Walking Obstacle Course
Kott et al. (2001) developed the Standardized Walking Obstacle Course (SWOC) as a tool for testing functional ambulation in children with CP. The SWOC is a designated walking path that is 39.5’ long and 36” wide made of low pile carpeting. Walking the course includes negotiating

three directional turns (30_ right, 90_ left and 70_ right), stepping over an auxiliary crutch, walking across a visually stimulating mat, stepping around a trash can, walking across a shag rug, and transitioning sit to stand and stand to sit from one chair with armrests to a chair without armrests. There are two stools (18 inches high) placed on opposite sides and ends of the course as a place to set a tray. Testing occurs under three conditions: walking with arms down at sides (hands free), carrying a lunch tray to block the view of the feet (walk with tray), or wearing shaded glasses (walk with glasses, that is walking with arms down at sides, but in a simulated dim lit environment).

The measures within the SWOC (time, number of steps, and observations of stability) are used in clinical practice for patient populations (Shumway-Cooke, & Woollacott, 2001). The SWOC has been used to test 360 children without disabilities (Kott, Held, & Franjoine, 2001) and 86 with developmental disabilities. (Kott, Held, Franjoine, & Engbretson, 2004; Held, Kott, & Young, 2006; Held, Barbour, & Kott, 2006; Held, Kott, Didas, & Mongel, 2007). It has high interrater (ICC= 0.95-.099) and intrarater reliability (ICC= 0.83-0.97) and concurrent validity (r=.79-.88) with the Timed Up and Go (Held, Kott, & Young, 2006). Previous research has shown that children with CP GMFCS Levels I and II walked 46% slower and took 35% more steps compared to non-disabled peers matched to their age, gender, height, and weight (Kott et al., 2001; Held et al., 2004). The slower walking speeds and increased effort of more steps (spatiotemporal parameters of gait) are hypothesized to make these children with CP less functional in their home and community environments.

Virtual Reality Game – Storyboard

To evoke meaning for children, the storyboard of the game was based on a story that included a princess and a dragon. The story began in the castle where the princess was taken by the dragon on her wedding day. The focus of the story was to walk to save the princess. Narration occurred at the beginning and end of the game and through various characters that appeared at uneven intervals in the story to give supportive messages. These characters included a dog, cat, elf, little girl, fairy, dragonflies, woodsman, and a knight (Figure 1). In addition to the main castle where the princess lived, two other castles appeared in the background (possible hideouts for the dragon), walking occurred in forests and towns and, at the end, the dragon's cave was found. Because the SWOC also has turns and obstacles, the game provided sharp turns and obstacles that occurred in the path such as the characters, trees, or rocks.

Integrating principles of motor learning, the game was goal directed (rescue the princess) and two forms of positive reinforcement occurred at uneven intervals. This reinforcement was given as the child met characters in their supportive messages ("keep walking we have to save the princess") and by earning points. Points accumulated in the concrete form of diamonds, coins, magic shield, staff and glue (used to fight the dragon at the end) that adhered to a *magic shirt* that the child wore. The inclusion of the *magic shirt* helped the child feel more immersed in the game.

Virtual Reality Game – Development

The VR game system, which was developed in the form of DVDs, consisted of three stages: 1) designing of the virtual environments, 2) rendering of the virtual environments, and 3) editing of the final video. To design the environments Lightwave was used. To decrease development time, a model of a castle was purchased. Two segments were developed; the first was 15 minutes long and showed a brick path with different buildings, objects, characters, and trees on either side. The second 10 minute segment developed showed the forest. To create several other segments, the position of the buildings, objects, characters and trees and the color of the brick pathway from the originals were randomly changed to make the environments diverse enough to give the impression of walking in different virtual environments. The images were rendered at the Virginia Modeling Simulation Center, using a cluster of nine computers (Pentium III, 1 Gigabyte RAM). It took approximately 2 weeks of 24/7 running time. The virtual environments were developed following the MPEG-4 standard that provides advanced coding and composition of a wide range of multimedia objects including real audio and video as well as synthetic objects such as 3-D scenes, textures, synthetic audio and even virtual human faces and bodies. Finally, by using Sony Vegas, the rendered images were combined in a movie, background music tracks (purchased in compliance with copyright laws) were added, and the

bonus point messages were superimposed on a predetermined time schedule. After editing, 15 packets of DVDs for a total of 9 hours of treadmill training were created. The first DVD introduced the story and the last provided the conclusion. The other DVDs contained 5, 10 or 15 minutes of training showing the various environments as indicated. The different time lengths were used because the children involved in project had different walking capabilities and were allowed to rest at the end of each DVD.

Participants

This research project received Internal Review Board approval from Eastern Virginia Medical School (EVMS). Informed consent was obtained from a parent of prior to data collection. Recruitment occurred from the Department of Physical Medicine and Rehabilitation EVMS. Inclusion criteria included; children with CP, no record of cardiopulmonary co-morbidity to impede the tasks, 4 to 15 years old with the abilities to ambulate without an assistive device other than orthoses, and follow simple instructions. The children's mobility was initially classified as Level I or II according to the Gross Motor Function Classification System (Palisano et al., 1997).

Intervention

Prior to any intervention on the treadmill, each child went through the pre-testing on the SWOC under each of the three conditions (walk hands free, walk with tray or walk wearing sunglasses). Each child was given verbal directions and a demonstration on how to negotiate the obstacle course. The verbal directions included the following: "use your typical walking, that is, how you move from one room to another at home or school and try to keep your feet on the carpeted path at all times". The child could be given cues to "stay on the path" while walking. When the tray is carried, additional directions include: picking up the lunch tray from the stool after standing up, walking through the course holding the tray level (horizontally), and placing it on the stool at the other end before sitting down. Each participant was given a practice trial of the walk hands free and walk with tray conditions prior to data collection. This was done to ensure the child's understanding of the different tasks. Trial one consisted of standing up, walking the course from the beginning to the end in one direction only, and sitting down. Walking through the course in the opposite direction was the second trial, after which a new condition of the SWOC began. Each child completed a total of six trials.

Measures collected were: 1) time required (taken using a digital stopwatch) and 2) count of number of steps, stumbles (any loss of balance or body contact with an obstacle along the course) and steps off the course (all or part of the foot touched the floor along side the path). Each child's initial walking speed on the treadmill was calculated from the time for the hands free walking condition. After the first data collection period, the child began the first game based VR training session.

Each child participated in VR-based treadmill training for 3-4 times per week until 9 hours of ambulation occurred. Treadmill progression was individualized according to each child's tolerance by increasing its speed generally by increments of 0.1 mph. During the virtual reality treadmill sessions, the participant walked in front of a multi screen system surrounded by high definition sound watching a DVD as described above. There was no connection between the treadmill and the DVD. The researcher started and stopped each DVD, changed the speed as appropriate, and encouraged the children to interact with the DVD. A research assistant stood behind each child while on the treadmill for safety. The children interacted with the story by 1) watching for the reinforcement to occur i.e. diamonds, coins, and characters to appear, 2) naming the characters, 3) guessing what was coming next, 4) describing the different settings and 5) commenting on the music. Testing on the SWOC was repeated at the end of training.

Data Analysis

For this pilot study, the data from each child were placed in an Excel file. Averages and standard deviations were calculated for the three conditions. Graphs were developed to visually inspect the pre and post-data.

Results

To date, three male children (Child A: 8 years GMFCS Level I, Child B: 4 years 3 months GMFCS Level I and Child C: 5 years 10 months GMFCS Level II) completed the 9 hours of walking over a 3 week period. Neither child A nor B had ever walked any length of time on a treadmill. Child C had previously walked on the treadmill in physical therapy up to maximum of 8 minutes per session at 0.6 mph. Overall; all participants were able to walk for 60 minutes sessions,

the only difference being the time frame by which they took to achieve this goal. The group showed averaged improved times pre-test to post-test for conditions of walk hands free (39% decrease), walk with tray (17% decrease) and walk with glasses (12% decrease) (See figures 2, 3,4) There were some individual differences which will now be discussed.

Child A's started at 0.9 mph and progressed to 2.5 mph. After the second day at 1.0 mph, child A stated the treadmill speed was too slow and it was increased to 1.5 mph for the fourth DVD. It was then increased by increments of 0.1 mph. Time walked was 15 minutes day one, 45 minutes days two and three, 60 minutes for days four through ten and 15 minutes day eleven. The pre-test to post-test scores for number of steps across all conditions decreased an average of 3 steps demonstrating improvement (longer strides). During pre-test and post-test, no stumbles and 1 step-off the path were noted demonstrating stability.

Child B's started at 1.0 mph and progressed to 1.7 mph. Time walked was 18 minutes day one, 60 minutes days two through nine, 45 minutes day ten, and 15 minutes day eleven. The greatest time change was a drop of 10 seconds from an average of 45 seconds (pre-test) to 35 seconds (post-test) while carrying the tray. While instability was demonstrated walking and carrying the tray, the stumbles decreased from 2 to 1 and steps-off the path from 5 to 2 from pre-test to post-test.

Child C walked into the testing area with two forearm crutches, but was able to walk short distances with no crutches at the start of the protocol. Initial speed was 0.8 mph and progressed to 1.1 mph. Time walked was 10 minutes day one, 45 minutes day two, 50 minutes day three, 60 minutes for days four through ten and 15 minutes day eleven. The hands free walking condition showed the most change; time decreased from 34 seconds to 30 seconds and number of steps decreased from 36 to 34. During all conditions and times of testing, stumbles occurred 1 time or less, but steps-off the path occurred 1 to 3 times. Anecdotally, the parent stated child C walked with only one crutch for longer distances outside and used no crutches inside the house by the end of the study.

Subjective Comments

Verbal feedback received from the children, parents, researcher (KMK), and student assistants involved with the training was both positive and constructive. The positive feedback included enjoying the time spent inside the castle and maze, climbing stairs, the lively music, uneven intervals for gaining points, and unexpected activity of the characters i.e. cat running backwards. Some suggestions for change of the DVDs include adding slightly more novelty in the walking environments and increasing the speed as the DVDs progressed to make the walking seem faster to the participants.

Conclusion

Overall, the results demonstrated that the DVDs were a great motivational tool for treadmill training. All three children stayed engaged enough to walk for one hour sessions and made some functional changes in their walking. This activity and the preliminary findings support previous studies that suggested that this technique merited further investigation (Deutsch et al, 2004) and that virtual reality could be useful for rehabilitation of children (Grealy & Heffernan, 2000) integrating play (Rodgers & Ziviani, 1999) and incorporating "best practice" (Valvano, 2005). The results also highlighted the usefulness of treadmill training for children with CP (Richards et al, 1997), but a limitation of this study is the small sample size.

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Figure 1. Characters from the VR Game.

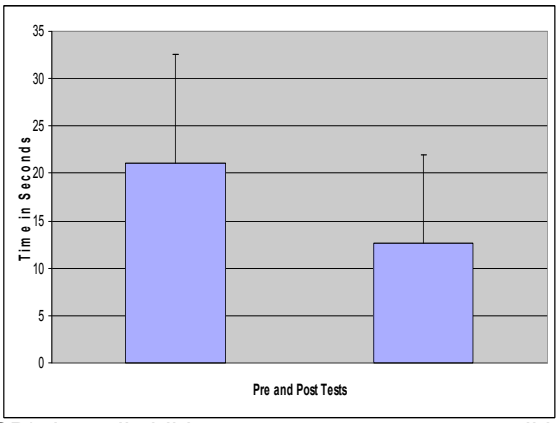

Figure 2. Average(SD) time all children pre-test to post test condition of walk hands free

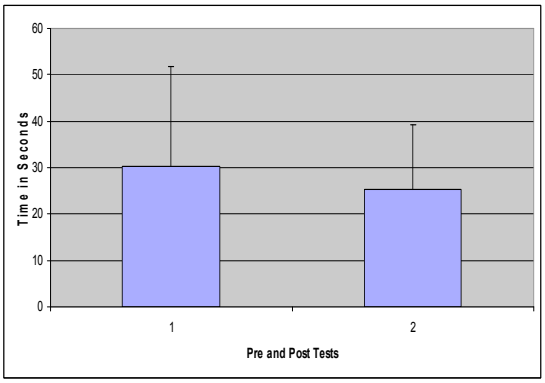

Figure 3. Average (SD) time all children pre-test to post-test condition of walk with tray

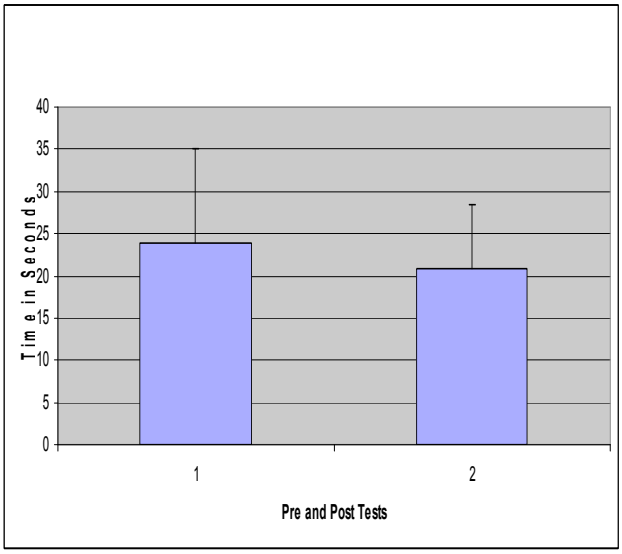

Figure 4. Average(SD) time all children all children pre-test to post-test condition of walk with glasses

Virtual Justina: a PTSD virtual patient for clinical classroom training

Kenny, P.,[1] Parsons, T.D.,[1] Pataki, C.S.,[2] Pato, M.,[2] St-George, C.,[2] Sugar, J.,[2] Rizzo, A.A.[1]

1 Institute for Creative Technologies, University of Southern California

2 Keck School of Medicine, University of Southern California

Corresponding Author: kenny@ict.usc.edu

Abstract: *The effects of trauma exposure manifests itself in a wide range of symptoms: anxiety, post-traumatic stress disorder, fear, and various behavior problems. Effective interview skills are a core competency for the clinicians who will be working with children and adolescents exposed to trauma. The current project aims to improve child and adolescent psychiatry residents, and medical students' interviewing skills and diagnostic acumen through practice with a female adolescent virtual human with post-traumatic stress disorder. This interaction with a virtual patient provides a context where immediate feedback can be provided regarding trainees' interviewing skills in terms of psychiatric knowledge, sensitivity, and effectiveness. Results suggest that a virtual standardized patient can generate responses that elicit user questions relevant for PTSD categorization. We conclude with a discussion of the ways in which these capabilities allow virtual patients to serve as unique training tools whose special knowledge and reactions can be continually fed back to trainees. Our initial goal is to focus on a virtual patient with PTSD, but a similar strategy could be applied to teaching a broad variety of psychiatric diagnoses to trainees at every level from medical students, to psychiatry residents, to child and adolescent psychiatry residents.*

Introduction

Although there are a number of perspectives on what constitutes trauma exposure in children and adolescents, there is a general consensus amongst clinicians and researchers that this is a substantial social problem. The effects of trauma exposure manifest itself in a wide range of symptoms: anxiety, post-traumatic stress disorder, fear, and various behavior problems. Trauma exposure is associated with increased risk of psychological problems in adulthood. Effective interview skills are a core competency for the clinicians who will be working with children and adolescents exposed to trauma.

Developing effective interviewing skills for the clinicians, residents and psychotherapists who will be working with children and adolescents exposed to trauma is a necessary skill. A clinician needs to ask various questions relating to the trauma and its effect to properly assess the patient's condition. Current therapeutic training systems resort to using real persons (hired actors or resident students) acting as standardized patients to portray patients with a given mental health problem in what is called an Objective Structured Clinical Examination (OSCE). The problem portrayed by the actor could be physical or psychological. Although schools commonly make use of standardized patients to teach interviewing skills, the diversity of the scenarios standardized patients can characterize is limited by availability of human actors and their skills. This is even a greater problem when the actor needs to be an adolescent, elder or portray a difficult condition. The potential of using computer generated virtual humans as standardized virtual patients (VPs) for use in clinical assessments, interviewing and diagnosis training is becoming recognized as the technology advances (Bernard et al., 2006; Bickmore, Pfeifer, Paasche-Orlow, 2007). These VPs are embodied interactive agents who are designed to simulate a particular clinical presentation of a patient with a high degree of consistency and realism (Kenny et al., 2007). VPs have commonly been used to teach bedside competencies of bioethics, basic patient communication, interactive conversations, history taking, and clinical decision making (Bickmore, Giorgino, 2006).VPs can provide valid, reliable, and applicable representations of live patients (Triola et al., 2006). Research into the use of VPs in psychotherapy training is in its nascent stages (Johnson et al., 2007; Parsons et al., 2008). Since virtual humans and virtual environments can allow for precise presentation and control of conversations and interactions, they can provide ecologically valid assessments that combine the control and rigor of laboratory measures with a verisimilitude that reflects real life situations.

The current project aims to improve child and adolescent psychiatry residents, and medical

students' interview skills and diagnostic acumen through practice with a female adolescent virtual human with post-traumatic stress disorder (PTSD). This interaction with a virtual patient provides a context where immediate feedback can be provided regarding trainees' interviewing skills in terms of psychiatric knowledge, sensitivity, and effectiveness. Use of a natural language-capable virtual character is beneficial in providing trainees with exposure to psychiatric diagnoses (e.g. PTSD), prevalent in their live patient populations, and believed to be under-diagnosed due to difficulty in eliciting pertinent information. Virtual reality patient paradigms, therefore, will provide a unique and important format in which to teach and refine trainees' interview skills and psychiatric knowledge. In order to be effective, virtual humans must be able to interact in a 3-D virtual world, must have the ability to react to dialogues with human-like emotions, and be able to converse in a realistic manner. The combination of these capabilities allows them to serve as unique training tools whose special knowledge and reactions can be continually fed back to trainees. The goal of this virtual patient was to focus on a character with PTSD; our previous effort was on a character with Conduct Disorder. The eventual goal is to build a library of characters with a variety of psychiatric diagnoses to train residents and students at multiple levels.

Method

Participants:
Participants were asked to take part in a study of novice clinicians interacting with a VP system. They were not told what kind of condition the VP had if any. Two recruitment methods were used: poster advertisements on the university medical campus; and email advertisement and classroom recruitment to students and staff. A total of 15 people (6 females, 9 males; mean age = 29.80, SD 3.67) took part in the study. Ethnicity distribution was as follows: Caucasian = 67%; Indian = 13%; and Asian = 20%. The subject pool was made up of three groups: 1) Medical students (N=7); 2) Psychiatry Residents (N=4); 3) Psychiatry Fellows (N=4). For participation in the study, students were able to forgo certain medical round time with the time spent in the interview and questionnaires.

Measures:
Virtual Patient Pre-Questionnaire. This scale was developed to establish basic competence for interaction with a virtual character that is intended to be presented as one with PTSD, although no mention of PTSD is on the test.

Virtual Patient Post-questionnaire. This scale was exactly the same as the Virtual Patient Pre-questionnaire and will be used in the future for norming of a pre-post assessment of learning across multiple interactions with the VP. In the future, we will also include social presence and rapport scales and include a control set that will just go thru a fixed script with the interview.

Justina Pre-questionnaire. We developed this scale to gather basic demographics and ask questions related to the user's openness to the environment and virtual reality user's perception of the technology and how well they think the performance will be. There were 5 questions regarding the technology and how well they thought they might perform with the agent.

Justina Post-questionnaire. We developed this scale to survey the user's perceptions related to their experience of the virtual environment in general and experience interacting with the virtual character in particular the patient in terms of it's condition, verbal and non-verbal behavior and how well the system understood them and if they could express what they wanted to the patient. Additionally, there were questions on the interaction and whether they found it frustrating or satisfying. There were 25 questions for this form.

Procedures:
One of the challenges of building complex interactive VPs that can act as simulated patients has been in enabling the characters to act and carry on a dialog like a real patient with the specific mental issues present for that condition in the domain of interest. Additional issues involve the breadth and depth of expertise required in the psychological domain to generate the relevant material for the character and dialog. The current domain of PTSD requires the system to respond appropriately based on certain criteria for PTSD as described in the DSM manual (309.81; American Psychiatric Association, 2000). According to the most recent revision to the American Psychiatric Association's DSM Disorders, PTSD is divided into six major categories (see DSM for a full description and subcategories):

A) Past experience of a traumatic event and the response to the event.

B) Re-experiencing of the event with dreams, flashbacks and exposure to cues.
C) Persistent avoidance of trauma-related stimuli: thoughts, feelings, activities or places, and general numbing such as low affect and no sense of a future.
D) Persistent symptoms of anxiety or increased arousal such as hyper vigilance or jumpy, irritability, sleep difficulties or can't concentrate.
E) Duration of the disturbance, how long have they been experiencing this.
F) Effects on their life such as clinically significant distress or impairment in social or educational functioning or changes in mental states.

Diagnostic criteria for PTSD include a history of exposure to a traumatic event in category A and meeting two criteria and symptoms from each B, C, and D. The duration of E is usually greater than one month and the effects on F can vary based on severity of the trauma. Rather than assessing for all of the specific criteria, we focused upon the major clusters of symptoms following a traumatic event. Next, we developed two additional categories that we felt would aid in assessing user questions and VP responses that are not included in the DSM:

G) A general category meant to cover questions regarding establishing rapport, establishing relations, clarifications, opening and closing dialog.
H) Another category to cover accidental mouse presses with no text, the user is required to press the mouse button while talking, or something that does not fit into the other categories.

For the PTSD domain we built an adolescent girl character called Justina, see Figure 1. Justina has been the victim of an assault and shows signs of PTSD. The technology used for the system is based on the virtual human technology developed at USC (Kenny et al., 2007; Swartout et al., 2006).

Figure 1: Justina Virtual Patient

The data in the system was logged at various points to be processed later. Figure 2 is a diagram of how the user interacts with the VP system and the data logging and annotation pipeline. The user speech is recorded from what s/he says; this lets us transcribe what the speech engine processes. Next the speech recognition client sends the recognized text to a statistical question/response system. Once an appropriate response is selected a behavior is generated for the character based on the response, the resulting behavior animation is shown in the graphical engine. A transcript of the entire dialog session is recorded along with the system logs. This data allows us to reconstruct what happened in the system if needed. Cameras recorded participant's facial expressions and system interaction with the patient to be analyzed at a later time. The set of responses Justina would say were classified into one of the DSM categories from above. This allowed us to assess the responses of the system to questions asked by the subjects.

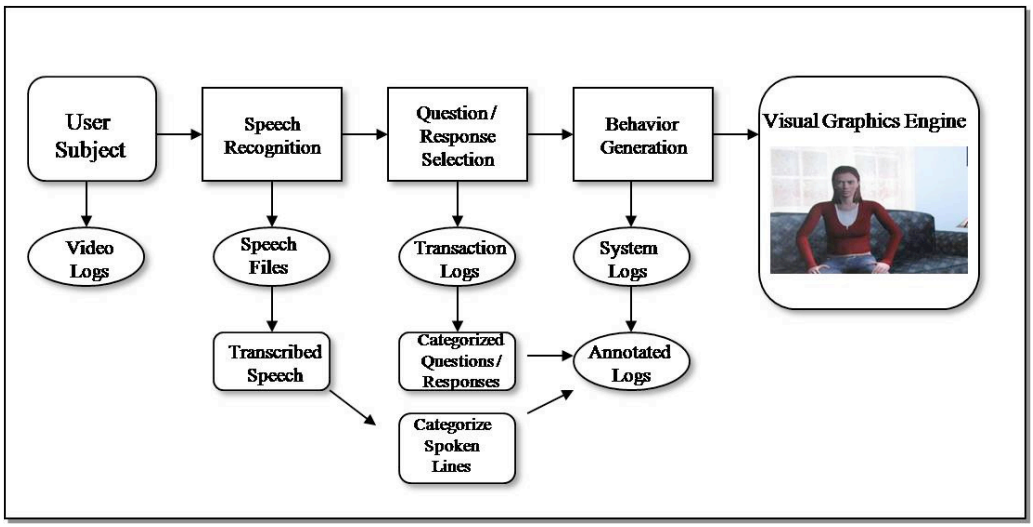

Figure 2: Interaction and Data Logging Pipeline

The subject testing was divided into three phases, a pre-test and pre-questionnaire, the interview and a post-questionnaire. The pre-test and pre-questionnaire were performed in a separate room from the interview and took about 10 minutes. For the interview the participants were asked to conduct a 15-minute interaction with the VP and assess any history or initial diagnosis of a condition of the patient. The participants were asked to talk normally as they would to a standardized patient actor, but were informed that the system uses speech recognition and was a research prototype. They were free to ask any kind of question and the system would try to respond appropriately. At the end of the 15-minute exchange they would be sent to another room to take the post-questionnaire. Assessment of the system was completed by the data gathered from the log files of the participants as they communicated with the VP in addition to the questionnaires. The log files allowed us to evaluate the amount and types of questions that the subjects were asking, along with a measure to see if the system was responding to the questions. After the subject testing sessions the set of questions were manually classified into one of the DSM categories.

Results

We aimed at investigating the relationship between a number of psychological variables and the resulting VP Responses. A summary of relations between each 1) DSM PTSD Category cluster of user questions; and 2) each (corresponding) cluster of responses from the VP representing the same DSM PTSD Category. Following standard convention, an effect size of 0.20 was regarded as a small effect, 0.50 as a moderate effect, and 0.80 as a large effect. Moderate effects existed between User Questions and VP Response pairs for Category A ($r = 0.45$), Category B ($r = 0.55$), Category C ($r = 0.35$), and Category G ($r = 0.56$), but only small effects were found for Category D ($r = 0.13$) and Category F ($r = 0.13$).

For a 15-minute interview the participant asked on average, 68.6 questions with the minimum being 45 and the maximum being 91. It is interesting to note that most of the questions asked were either general questions (Category #G, 362 questions) or questions about the Trauma (Category #A, 200 questions), followed by category #C, 126 and #B, 123. The larger number of questions asked in #G was partially due to clarification questions, however we did not break down the category further to try to classify this. It is also interesting to note that the distribution of questions in each category for each participant were roughly equivalent. Which means in general people asked the same kinds of questions, maybe due to the fact that they have all had the same training.

From the post questionnaires on a 7-point likert scale, the average people rated the believability of the system to be 4.5 and people were able to understand the patient, 5.1. People rated the system at 5.3 as frustrating to talk to, due to speech recognition problems, out of domain questions or inappropriate responses. However most of the

participants left favorable comments that they thought this technology will be useful, they enjoyed the experience and trying different ways to talk to the character and trying to get an emotional response for a difficult question. When the patient responded back appropriately to a question they found that very satisfying.

Discussion

Herein we presented an approach that allows novice mental health clinicians to conduct an interview with a virtual character that emulates an adolescent female with trauma exposure. The work presented here builds on previous initial pilot testing of virtual patients and is a more rigorous attempt to understand how to build and use virtual humans as virtual patients and the many issues involved in building domains, speech and language models and working with domain experts. The lessons learned here can be applied across any domain that needs to build large integrated systems for virtual humans. We believe this is a large and needed application area, but it's a small enough domain that we can perform some serious evaluations on using virtual humans in real settings.

Findings suggest that the interactions between novice clinicians and the VP resulted in a compatible dialectic in terms of rapport (Category G), discussion of the traumatic event (Category A), and the experience of intrusive recollections (Category B). Further, there appears to be a pretty good amount of discussion related to the issue of avoidance (Category C). These results comport well with what one may expect from the VP (Justina) system. Much of the focus was upon developing a lexicon that, at minimum, emphasized a VP that had recently experienced a traumatic event (Category A) and was attempting to avoid (Category B) the experience that may lead to intrusive recollections (Category C). However, the interaction is not very strong when one turns to the issue of hyper-arousal (Category D) and impact on social life (Category F). While the issue of impact on social life (Category F) may simply reflect that we wanted to limit each question/response relation to only one category (hence, it may have been assigned to avoidance instead of social functioning), the lack of questions and responses related to hyper-arousal and duration of the illness (Category E) reflects a potential limitation in the system lexicon. These areas are not necessarily negatives for the system as a whole. Instead, they should be viewed as potential deficits in the systems lexicon.

It is our belief that with more questions covered in the domain the accuracy of the system will rise along with the depth of the conversions, which will further enhance the virtual patient system. In order to be effective virtual humans must be able to interact in a 3-D virtual world, must have the ability to react to dialogues with human-like emotions, and be able to converse in a realistic manner with behaviors and facial expressions. The combination of these capabilities allows them to serve as unique training and learning tools whose special knowledge and reactions can be continually fed back to trainees. Our initial goal of this study was to focus on a VP with PTSD, but a similar strategy could be applied to teaching a broad variety of psychiatric diagnoses to trainees at every level from medical students, to psychiatry residents, to child and adolescent psychiatry residents.

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Mobile inclusion through science learning for the blind

Jaime Sánchez, Fernando Aguayo

Department of Computer Science, University of Chile

{jsanchez, faguayo}@dcc.uchile.cl

Abstract: *Science learning is a complex task for school-age children, especially blind children. The purpose of this study was to develop and evaluate user perception and acceptance of AudioGene, a role-playing videogame that uses mobile technology and adaptive interfaces so that blind and sighted children can learn science and work together collaboratively, as well as the role that the program played in the integration of blind children into the school environment. A usability evaluation demonstrates that blind users felt integrated with and subjected to the same conditions as their sighted peers when gaming, which shows that there is a real possibility for integrating blind users into the school by using digital technology. The methodology and tools utilized in this study can help in that direction. Future work should identify new ways of integration and determine whether the genetic content embedded in a videogame can assist the student in learning, and as such become a powerful tool for collaborative science learning of both blind and sighted learners alike.*

Introduction

The social inclusion of blind people into learning environments through the use of technology can be studied by making an analysis of four fundamentally related areas; these are the complexity of learning science, the benefits of mobile devices, the use of videogames for education, and mainstream integration.

School-level science learning can be complex for students due to the abstraction associated with the concepts involved and the impossibility of recreating similar environments. In many cases science is mostly studied theoretically because of the difficulties in correctly implementing practical activities (Johnstone, 1991). Technology plays a major role in explaining these concepts through simulations and games that can sum up processes that normally take hundreds, thousands or millions of years in a few minutes or seconds (Gibson, 2007).

Mobile devices provide the users with the possibility of using times and spaces that are not currently used for knowledge acquisition (Williams, Jones, Fleuriot, & Wood, 2005). The use of mobile devices also eliminates the barriers imposed by interacting in a small space and allows for a more fluid communication between the participants. The use of PCs in school learning generally involves the existence of a laboratory that limits the space for interaction (Salinas & Sánchez, 2006).

One of the most common student activities when using information technology is to play computer games or videogames (Mayo, 2007). Various studies show the importance of using games for education (Squire, 2003, 2005; Steinkuehler 2004), highlighting that relevant cognitive skills (Steinkuehler, 2008), such as the development of competition and concentration skills, mobility skills, language and mathematical skills, visual skills and also problem solving abilities, can be developed through the use of games (Klopfer & Yoon, 2005).

Many authors have analyzed the impact of games on problem solving skills. Some propose that games can promote higher order learning, such as increasingly meaningful dialogues among learners (McDonald & Hannafin, 2003). Other studies describe the positive effects of games on social skills (Pellegrini, Blatchford, & Kentaro, 2004).

Danesh, Inkpen, Lau, Shu, & Booth (2001) propose *GeneyTM*, a collaborative application for problem solving that teaches genetics through the use of PDAs oriented towards children. Some studies on problem solving and blind learners can be found in the development and analysis of games like *AudioChile*, *AudioVida* (Sánchez & Sáenz, 2006), and the various games mentioned

by Eriksson & Gärdenfors (2004).

Squire (2005) poses that it is not enough to produce educational video games, but that we must adopt a new methodology based on the way of teaching in schools, proposing five aspects that must be considered: 1. Focus the contents on more transversal and less specific aspects, in a way that the students actual study and understand causes and effects and the 'why' of things. 2. Consider the heterogeneity of the group in as much as interests, abilities and capacities for learning. 3. Accommodate the schedules in a way so that a student who is interested in a subject will be able to deepen his learning. Other times outside of class can be used so that the students study concrete subjects. 4. Diversify the means of transmitting knowledge, not being limited to the classic means used by the teacher (books, movies or presentations). For example, using video games allows students to work outside of regular class schedules, motivates them and gives them another perspective on the content. 5. Orient the evaluations to have an opportunity to support learning.

School integration is a key issue in education. Some studies present and analyze the integration of learners with disabilities into the classroom, such as in the research done by Johnstone (1991). Other studies promote the key role that technology can play for the integration of users with different kinds of disabilities into the classroom (Roper, 2006). In the work done by de Freitas & Levene (2003), a complete analysis of the development of mobile devices for education is shown. Emphasis is made on the possibility of using these devices for helping users with disabilities. Particularly, they mention the benefits that can be obtained thanks to new technologies used in locating places, helping with mobility, and cognitive assistance for orientation in real environments (Rodrigues, 2006; Na, 2006). The use of technology appears to be a real alternative for people with visual disabilities in order to be able to interact and collaborate with sighted users, extending the possibilities for communication and participation in situations in which they could not traditionally be found (Chen, 2005; Dowling, Maeder & Boldes, 2005). In conjunction with this, applications have been developed to improve the strategic and analytical capacity for problem solving, which is a fundamental skill for professional, intellectual and personal development (Jaroslavsky & Narvaja, 2004).

The purpose of this study was to develop and evaluate the user's perception and acceptance of *AudioGene*, a role playing videogame that uses mobile technology and adaptive interfaces so that blind and sighted children can learn science and work together collaboratively, as well as the role that the program played in the integration of blind children into the school environment.

Research questions

Blind children face different problems when interacting with others. First, they generally do not learn together with sighted peers. Their education tends to be separated from sighted children either in special schools or even in the same mainstream school, but using different learning tools. Particularly, they do not learn science and specifically biology with their sighted partners, because science learning is generally based on visual experiences. Secondly, they also do not tend to interact or socialize with sighted children because they are either isolated in special schools or integrated into regular schools but with little or no learning activities included in the curriculum that are planned and implemented to stimulate interaction and collaboration between sighted and blind learners. Finally, blind children generally do not talk, dialogue or discuss with sighted children because the former tend to socialize only with other blind children.

These issues leave us with two questions as the basis for this research: 1. Can mobile technology through gaming assist with problem solving skills in biology and help with the integration of blind children into the school environment? 2. Can mobile technology stimulate science learning in blind children as well as their integration with their sighted partners during the learning process?

Conceptual and cognitive emphasis

The way students interact during the learning process is an important and primordial aspect of learning. To learn with others and from others is indispensable for more complete learning. Students operate in a society and, most importantly, in a global society, so the emphasis on collaborative work and learning is essential (OECD, 2001). On one hand, our software emphasizes the collaborative work between blind and sighted children for solving biology problems using both graphical (for users with partial vision) and audio interfaces. On the other hand, we try to encour-

age students to face the learning process in a motivating way, testing and practicing knowledge through gaming and focusing on problem solving.

The software metaphor includes the use and learning of various concepts in genetics such as DNA, mutation, genotype, phenotype and gene. The contents have been taken from 7th to 10th grade school science textbooks that focus on the subject of genetics. Thus, a virtual world has been modeled considering each user as a key constituent who must adopt a character when gaming.

Finally, the goal of *AudioGene* is not just to teach biology concepts to users, but to strengthen and help them put the knowledge they have acquired in their science class into practice.

The design of AudioGene

AudioGene has been designed for mobile use through handheld devices (Pocket PC), but it can be also used with other Windows mobile devices such as cell phones, TabletPCs, UMPCs, etc. This is possible due to the use of a .NET framework that, with minimal modifications, can be implemented in other similar platforms.

AudioGene world

The game takes place in a virtual world embedded with lava, water, mountains and earth, based on school-level genetics material, and in which the user has to perform as and control a character. The game presents a story that consists of a tree of life that has certain characteristics, such as being robust, alive, wise and leafy. The user is given the scenario that the tree is dying, so it has to be replaced by another tree with the same characteristics, by using a combination of seeds that will result in a similar tree. In order to achieve the goal of the game, successfully replacing the tree, the user's character has to evolve into certain superior entities. He or she can evolve by learning about concepts in genetics and other knowledge. This can be done in three ways: 1. The user travels around the world freely and interacts with the characters that he/she meets; 2. The user solves a specific mission within the game; and 3. The user, in conjunction with his/her partners, solves a mission.

Interfaces

The graphic interface was designed for sighted and some legally blind users with partial vision. For all legally blind users we used an audio interface that is explained in the Audio Interface chapter. The fact that we were working with a Pocket PC device limits the design of the interface due to its reduced size. This forced us to go with a minimalist design, favoring an adequate degree of interaction without overcharging the user or the screen. To accomplish this, the use of buttons and status information was avoided. The only status information provided through the graphical interface is a figure that appears at the left top of the screen highlighting when the user acquires a certain skill (see Figure 1).

The engine developed for *AudioGene* allows for the handling of layers (see Figure 2) for the different objects that are drawn on the screen, and thus provides a more realistic spatial representation with a feeling for depth, so that objects can be placed in front of or in back of the other objects.

The audio interface consists of two types of sounds: 1. Icon audio is used for spatial orientation and consists of using sound clues. These sounds may correspond to the area in which the user is located. For example, when the user is over the water, a sound associated with water is played. These sounds are also utilized in order to

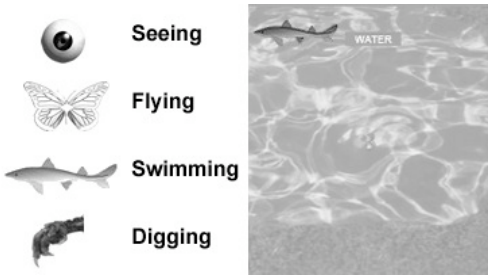

Figure 1. Each skill is represented by a different symbol.

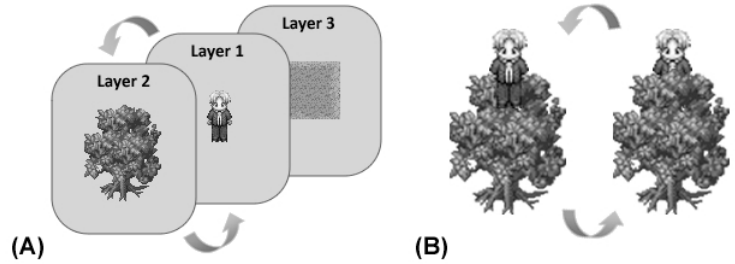

Figure 2. (A). The handling of layers. (B). The result of applying layers can be appreciated by looking at the character situated behind or in front of the tree.

inform the blind user about the location of other users or Pocket PC controlled characters by using the audio interface explained below. 2. Speech audio corresponds to pre-recorded sentences that are used to teach the user about genetics and to ask blind users questions when they approach a Pocket PC controlled character.

With icon audio a problem emerged, in that the Pocket PC device is only capable of playing stereo audio. Efforts have been made in order to provide the user with the feeling of three-dimensional space. It is well known that headsets only allow for the use of 2 sound sources (A and B in figure 3), which makes for the possibility of 3 spatial combinations. The first two combinations correspond to only one of the sources being used (it is identified as left or right), and the other one is achieved through the use of both sources (which is intuitively identified as front) (Lumbreras & Sánchez, 1999).

This model was extended by adding a new variable (C) to the sound system. This sound is mono channel and sounds constantly together with the sound from the audio source as if it were coming from behind the user. This sound allows for three new combinations, expanding the spatial system to a total of six combinations. So the user can listen to a sound with the speaker on his right (B in figure 3A), his left (A in figure 3A) or on both (A+B in figure 3A), which means that the audio source comes from his right, left or center respectively. If the base sound is added to these sounds (C in figure 3A), then the audio source would come from the rear right of the user (B+C in figure 3A), the rear left of the user (A+C in figure 3A) or from the rear center (A+B+C in figure 3A).

When adding a rear sound for the user (C), a proposed system such as the one shown in Figure 3A is obtained.

Database & Networks

AudioGene allows for online multiplayer games, so the need for a centralized information system emerges. A PC with a database is required and the Pocket PCs are in charge of updating their information through the network. When the user starts a session, the Pocket PC communicates with the PC, which sends the player's last known status back to the Pocket PC, guaranteeing the continuity of the game. This database records the state of the game, including the location of the different players, the skills they have acquired and the travel map.

Figure 3B shows the interaction between the Pocket PCs and the servers through web services. This communication takes place when starting and ending a game session, allowing the user to get the information stored the last time he/she played and then to store the information again in order to access the new state of the game for the next session. The use of web services allows for the use of Pocket PC devices behind a firewall to communicate with the server.

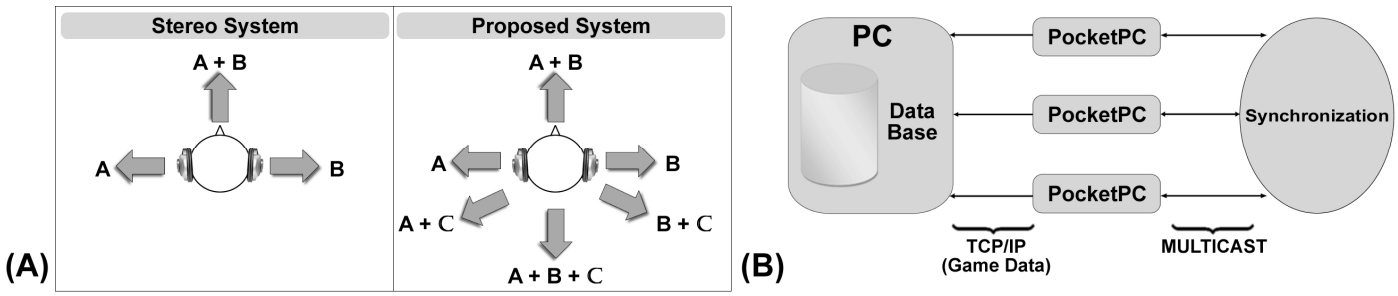

Figure 3. (A) Audio system proposed for *AudioGene*. (B) A logic-based diagram of interaction

Methodology

Participants
The sample consisted of five legally blind children and three sighted children. They were distributed in two groups of four children each. Each of these groups contained one blind user and three sighted users or users with visual disabilities. Two out of five blind children were totally blind and three had residual vision (see Figure 4C). Four children attended the "La Maisonette" school that runs a school integration program (mainstreaming) and four attended the "Escuela de Ciegos Santa Lucía", both of which are located in Santiago de Chile (see Figure 4A-B). Two facilitators participated in the study, one from the team that developed *AudioGene* and a special education teacher who specializes in visual disabilities.

Instruments
In order to gather data and information about the blind learners' opinions, perceptions, and their acceptance of the software and the experience of gaming with their sighted partners, an open-answer questionnaire was administered. Questions such as, "How do you play with your partners?", "What do you think about *AudioGene*?", "Did you like to play *AudioGene* with your friend?", "Do you like science?", "What do you think about this new way of learning?", "Would you like to play more games like *AudioGene*?", and "Would you play *AudioGene* again?", were asked.

The purpose of these open-ended questions was to obtain opinions, perceptions and the degree of the software's acceptance from the users that played the game and who interacted fully with their partners. The question, "How do you play with your partners?" was intended to identify the real way in which blind children played in conjunction with their sighted partner, coming to understand, as such, the novelty that a game like *AudioGene* might represent for them. The rest of questions focused on getting information about the software, the experience with the software and the way that it contributes to school integration and learning.

Procedure

The following are the stages used in order to administer the survey: 1. *Introduction to the game*. The user receives explanations about the purpose of the game and how to use the Pocket PC device; 2. *Interaction with AudioGene*. Users have to navigate the virtual environment and collaborate with their team peers. The two groups played *AudioGene* during four 30-minute sessions during a one-month period of time, and were all made to complete the same mission collaboratively between the 4 team members; 3. *Administration of the questionnaire*. When the children finished the four sessions of interaction with AudioGene, they were given the questionnaire in order to gather data and information about their opinions, perceptions, and acceptance of the software and the experience of gaming with their blind or sighted partners. The users answered the questions in the questionnaire, which was administered verbally by the facilitators.

Results

The results having to do with the users' perceptions of playing and interacting with *AudioGene* were analyzed. None of the children that participated had ever interacted with a mobile Pocket PC device before. They only knew about them through the media. The most similar device with which they were well familiarized and that they handled daily was a cell phone.


(A)


(B)

(C)

#	Age	Gender	Diagnostic Ophthalmologic	Degree of Vision
1	13	M	Bilateral Optic atrophy	Residual Vision
2	14	F	Retinopathy of Prematurity	Totally Blind
3	13	M	Microphtalmos	Residual Vision
4	15	M	Aniridia, Glaucoma, Cataract	Residual Vision
5	10	F	Hypoplasia of Optic Nerve, Iris Colomba, Microphtalmos	Totally Blind

Figure 4. (A) Children playing *AudioGene*. (B) "La Maissonette" school students "Escuela de Ciegos Santa Lucía" students. Children interacted in places other than the formal classroom. (C) Ophthalmologic characteristics and diagnosis of participants with visual disabilities

How do you play with your classmates? One of the answers to this question was "we play soccer matches". To do this, they put the ball inside plastic bags in order to hear when the ball is moving. Thanks to this sound children with visual disabilities are able to follow the movements of the ball and play without any problems. Also, most of the children reported that they do not play any games in common with both sighted and blind children playing together.

One of the children that participated and who knew of *AudioLink* (Sánchez & Elías, 2007), a desktop game for the orientation, mobility and science learning of blind children through virtual environments, said, *"…sound based computer games like Link is a game that includes sounds and teaches us how to orient ourselves in an easy and entertaining way.*"

One totally blind girl that participated in the study did not have any sighted friends. She only interacted with blind children, so she was very excited about the idea of interacting, playing and meeting sighted children. Some of her partners that have partial vision said, "*… it was very interesting to play with sighted children.*"

What do you think about *AudioGene*? All of them found that *AudioGene* was entertaining and motivating. They focused mainly on the possibility of accomplishing tasks in conjunction with their partners. Sighted children liked and enjoyed playing with their blind partners. For the blind children, the fact of being able to work in conjunction with their sighted partners through the use of technology was a very good experience, and they liked to participate and work as a team with them.

Did you like to play with your friends? Both teams agreed that to play all together was a very good experience. They could participate and achieve the proposed objective collaboratively as a team, as well as pursue individual tasks.

Do you like science? All learners liked science courses. They found them entertaining and interesting, but not all of them found science easy. Most of them considered it to be a difficult subject. A blind girl said, "*Yes, I like it and find it interesting, but it is difficult for me to understand and learn science.*" Another one said, *"… I like it more when they teach you about space and animal subjects, by asking questions. Some topics are very complicated and are more difficult to understand than others.*" Some of the children said that when they can not understand the contents, they do not like it anymore, *"… I like it when we learn about animals and that kind of subject, when we do not understand something we don't like it*." *AudioGene* made them understand a difficult subject, such as genetics, in an entertaining and different way.

What do you think about this new way of learning? Children found this way of learning more entertaining than reading books, and also more motivating. A blind girl even added, "*I am going to propose it to my teacher…*" meaning that she will suggest that her teacher adopt this kind of teaching method. The rest of her partners supported this idea in saying, "*Yes that would be very interesting*".

Would you like to have more games like *AudioGene*? All children answered that they would like to have more games like this one. They established that one of the advantages is that they can interact, play and learn all together. A blind girl stated, "It is *good, because all of us can be there and is fun to play with it. Especially in the way that it teaches that all the people in the world are different; there is no single person that is equal to another. Some can cross over lava, others can cross over water, but the ones that can cross over lava can not cross over water.*" The idea being transmitted here has to do with the metaphor used in the game, which teaches that all people are different and have different skills and virtues. One of the children supported the idea of creating and have more integrated games, and concluded, *"… we can not live in a world where all people are sighted, or in a discriminating world where the sighted are separated from blind people.*"

Blind users not only felt integrated with their sighted partners, but they enjoyed this kind of integration and the feeling of not being limited in their interaction with sighted people as well.

Would you play *AudioGene* again? All the children answered yes to this question. This motivates us to continue working with this tool in the future and to test its capacity for the development of learning skills. A blind girl also added, "*The interesting thing about games is not only playing with sounds, but being able to touch and feel the*

game as well."

Conclusion

The purpose of this study was to develop and evaluate the users' perceptions and acceptance of the software, and the role that these played in the integration of *AudioGene* into the school environment. *AudioGene* is a role-playing, mobile videogame used to learn science and for collaborative work between sighted and blind users.

Klopfer and Yoon (Klopfer & Yoon, 2005) said that games produce a high level of commitment and motivation in learners, and that these attributes can be useful for improving learning activities. In this study, blind users accepted and were highly motivated to use *AudioGene*. They felt that they were in the same condition as their sighted partners. This is never the case when using technology in general. Also, all the children who participated in the experience, blind and sighted alike, recognized that learning science is interesting, but that sometimes it is difficult to follow without losing their motivation in the end.

AudioGene proposes a new way for learning science, and specifically genetics. The main achievement of this game is that children take an active and constructive role, learning in an interactive and motivating way. The children enjoyed this new way of learning; they felt motivated and participated in the tasks involved actively and in collaboration with each other during the course of the game.

Children had to organize themselves in order to define a strategy and achieve the proposed task. All of them did this task well and achieved the end goal. This is an important result in terms of the utility of the problem solving methodology. *AudioGene* helped to integrate blind and sighted users, stimulating science learning for legally blind users. This game has embedded problem solving tasks for science learning that can be used anytime, anywhere, and through the participation of blind and sighted users under the same conditions. Also, the game helped to produce a work environment in which differences were forgotten and children interacted freely with each other. They shared ideas to solve the proposed problem, and knowledge was constructed between all four members of each team.

It is widely known that it is important to generate spaces in which children feel motivated to learn and construct knowledge. In this direction, new technologies can help a great deal, especially from the perspective of communication and collaborative work. This new way of learning has to be accessible for all users without leaving anyone out. A tool like *AudioGene* opens the possibility of constructing spaces where blind and sighted children can work together and achieve common goals.

The experience presented by de Freitas & Levene (2003) is complemented by the results presented here, because we show that mobile devices can not only help legally blind users pursue their learning tasks, but their integration with a tool such as *AudioGene* as well, which represents a powerful tool for social integration. What Pellegrini et al., (2004) mentioned is corroborated in this study as well, because the use of *AudioGene* allows blind children to be socially integrated with their sighted partners, to participate actively in society, to be interested in learning science material and to use learning methods like gaming with digital and mobile devices. Judging from the children's comments, we highlight the fact that the game allowed legally blind children to work fully integrated with the sighted children, and to feel as part of the whole group. This is very important in order to achieve an improved and more complete learning process, not only of the subject matter, but skills for working collaboratively as a team as well.

The *AudioGene* game focuses on the current and very important issue of the integration of children with visual disabilities and their sighted partners in school, as the former are considered as a segregated population. It also uses mobile technologies and modern methods for school-level science learning. The fact that it is a mobile application allows the children to go outside their classrooms and develop naturally in other environments, with the assistance of technology. The use of non-formal learning spaces like museums, zoos and squares for learning by a variety of users is a new window of opportunity opened by applications like *AudioGene*.

Future studies should identify the degree to which school integration can be attained by working with tools like *AudioGene* in more depth. In this paper, qualitative, preliminary, and exploratory data was presented that has served as a base in order to formulate a new, more long-term

project with an intervention in nine integrated schools, from which more complete quantitative and qualitative data is expected to be obtained.

In addition, interventions with *AudioGene* in environments outside the classroom, like a museum, could be a challenging task in the search for innovative ways to learn science.

Acknowledgements

This report was partially funded by Fondecyt, Project 1060797 and PBCT-CONICYT, Project CIE-05.

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Clinical Observation

BlindAid: a virtual exploration tool for people who are blind

Orly Lahav, Ph.D. David W. Schloerb, Ph.D.
Siddarth Kumar, and Mandayam A. Srinivasan, Ph.D.
Massachusetts Institute of Technology, Cambridge, MA, USA

lahavo@mit.edu

Abstract
For most people who are blind, walking in an unknown environment can be unpleasant, uncomfortable, and unsafe even after extensive orientation and mobility rehabilitation training. This study is based on the assumption that the supply of appropriate spatial information through compensatory sensorial channels (e.g., haptic and audio) within a virtual environment simulating a space in advance may assist people who are blind in their anticipatory exploration and cognitive mapping of the unknown space. In this study we developed and tested the BlindAid system that combines 3D audio with a Phantom^{O} haptic interface so as to allow the user to touch a virtual environment through a hand-held stylus. The two main goals of the study were: (a) development of the BlindAid system which allows people who are blind to explore an unknown virtual space, and (b) evaluation of different types of haptic feedback, audio feedback, and navigation tools and their effects on user behavior and spatial cognition. Our experiments included four participants who are totally blind. The findings supply strong evidence about the type of haptic feedback that the users preferred and confirmation that haptic feedback helped them explore and navigate in the virtual environment. The results also show that audio feedback helped the users orient themselves in the space. In general, the system provided a robust foundation for the participants' development of comprehensive cognitive maps. (Supported by a grant from National Eye Institute, NIH.)

Introduction

The fundamental role played by sensory systems such as vision, hearing and touch in our everyday lives is often taken for granted. A basic task such as navigation requires a coordinated combination of sensory and cognitive skills. Unfortunately, people who are blind face great difficulties in performing such tasks. Research on O&M skills of people who are blind in known and unknown spaces (Passini & Proulx, 1988; Ungar, Blades & Spencer, 1996) indicates that the support for the acquisition of spatial mapping and orientation skills should be supplied at two main levels: perceptual and conceptual. At the perceptual level, the deficiency in the visual channel should be compensated by information perceived via other senses. Thus, the haptic, audio and smell channels become powerful information suppliers about unknown environments. At the conceptual level, the focus is on supporting the development of appropriate strategies for an efficient mapping of the space and the generation of navigation paths. Over the years, information technologies were developed to help people who are blind build cognitive maps and explore real spaces. There are two types of O&M aids: passive aids that provide the user with information before his or her arrival to the environment (a verbal description of the space, tactile maps, strip maps, and physical models) and active aids that provide the user with information about the environment in-situ (Sonicguide, Talking Signs, activated audio beacon by using cell phones technology, and personal guidance system based on satellite communication). However, there are a number of limitations in the use of these passive and active devices. For example, the limited dimensions of tactile maps and models, and the used only of the active devices in the explored space and not in advance.

Over the past few years, the virtual reality has been used for rehabilitation and learning environments for people with disabilities (Schultheis & Rizzo, 2001; Standen, Brown & Cromby, 2001). Advanced haptic interface technology, enables blind individuals to expand their knowledge by using artificially made reality through haptic and audio feedback (Sjotrom & Rassmus-Grohn, 1999; Karshmer & Bledsoe, 2002; Yu, Ramloll & Brewster, 2001; Parente, & Bishop, 2003; Lahav and Mioduser, 2004; Semwal & Evans-Kamp, 2000).

The research reported in this paper attempted to examine the haptic-audio VE properties, by participants who are blind. The main research questions of this study were:

1. Which haptic feedback properties used in the VE strongly affected the participants?
2. Which audio feedback properties maximized the participant's exploration performance in the VE?
3. Which properties of the exploration tools maximized the participant's performance?

The rest of this paper is organized as follows. In the next section, we will briefly describe the BlindAid system that was developed specially for this experiment. Next we will present the research method. We will then present the experimental results, and we will conclude with a discussion on the merits of using BlindAid system.

The BlindAid System

Developed by the Touch lab at MIT, the BlindAid system consists of a software package that provides a VE for people who are blind and a haptic device. The system was designed through active collaboration between engineers, learning scientists at the MIT Touch Lab, an expert on 3D audio in VR, and an O&M instructor from the Carroll Center for the Blind (see Figure 1).

Using this human-machine interaction, the user gets haptic and audio feedback. The haptic interface allows the user to interact with the VE and provides two functions, it moves the avatar through the VE, and it provides force feedback to the user that gives clues about the space similar to those generated by the white cane. In this study we propose to use the Phantom, a haptic interface with high fidelity in force generation and position tracking.

The Phantom produces a mechanical force during a maneuver in the VE if the tip of the stylus attached to it penetrates any virtual object in the VE. The reaction force is rendered in the direction normal to the surface of collision if the surface is frictionless, but forces in other directions are also rendered to simulate surface textures. This lets the user gain knowledge of the spatial configuration of the touched object. Based on how the user contacts a surface, the computer determines these forces, which are then converted to a pulse-width-modulated motor current commands that generate the sensation of contact through the stylus grasped by the user. These forces at the fingertips lead the user to recognize the position and orientation of any surface that is being touched (Wang & Srinivasan, 2003). Our system uses variations in texture, friction, and softness to indicate environmental features.

The VE consisted of three types of objects: objects with only stiffness properties, objects with only textures properties, and objects with a combination of both stiffness and texture properties. The objects with only stiffness properties were characterized by four parameters namely; spring stiffness, a damping coefficient, and friction (static and dynamic). The objects with only texture properties were characterized by using a unit "bump" that was repeated over a line to develop a surface texture. There were two types of such bumps used: a saw tooth bump and a sine wave bump. The saw tooth bump (shown in Figure 2a) was characterized by four parameters: height (h), bump width (P), slope of the edges of the saw tooth (K), and horizontal flat (Pb). The sine wave, on the other hand (shown in Figure 2b), is defined by three parameters: height (h), bump width (P), and slope at half the height (K).

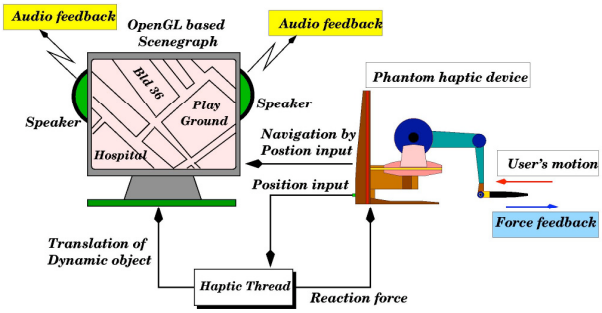

Figure 1: Schematic Diagram of Hardware System

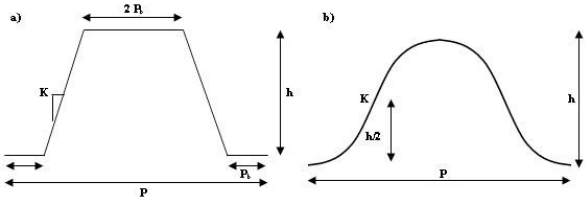

Figure 2: Haptic Force

In addition to haptic feedback through the Phantom, the user is also given 3D audio feedback through stereo headphones. The audio feedback provides the user with descriptive information as well as sound cues for various artifacts he comes into contact with in the VE. To simplify the signal processing, the Head Related Transfer Functions (HRTFs) were used for this virtual 3D audio processing. Additionally, the virtual 3D sound simulation "spatializes" sound using the orientation of the Phantom stylus to indicate the participant's head orientation. When audio feedback is triggered, the system processed the sounds using the specified HRTF and presented them to the participant via the headphones.

The BlindAid system comprises two modes of operation a developer mode and a learning mode.

The Developer Mode - The core component of the developer mode is the VE editor. In order to create VEs, first a CAD drawing of the geometry is created and imported into our developed editor in dxf format. The various components within the CAD drawing are then assigned haptic and audio parameters. Then the maps are stored as vmap data files.

The Learning Mode - The learning mode, within which the user and the researcher works, includes two interfaces:

1. User Interface – The users' station consists of a tabletop space with an arm support, a computer, keyboards, a set of stereo headphones, and the Phantom device through which the participant interacts with the VE. The user interface consists of the VE that simulates real rooms and objects to be navigated by the users using the Phantom. In addition to the Phantom, the user is able to interact with the VE by using the numeric keyboard.
2. Researcher Interface - The researchers' station consists of a flat panel computer monitor, a mouse, and an additional keyboard that is used as an aid for researchers to observe the progress of the participants in the VE during the experiments. On-screen monitors present updated information on the user's navigation performance, such as position or objects already reached. An additional feature allows the researcher to record the participant's navigation path and replay it to analyze and evaluate the user's performance.

Methodology

Participants The study included four participants who were selected on the basis of seven criteria: total blindness; at least 21 years old; not multi-handicapped; received O&M training; English speakers; onset of blindness at least two years prior to the experimental period; and comfortable with the use of computers. All the participants reported previous experience with computer applications, but no previous experience with VE or haptic devices. The participants ranged in age from 41-53 years old. One participant was congenitally blind and three were late-blind; one was female and three were male. To evaluate the participants' initial O&M skills, all were asked to individually complete a questionnaire on O&M issues. The results showed no differences in initial O&M ability among participants.

Research Instruments The research included seven instruments: two for the implementation and five for the collection of the data. The two instruments for the implementation of the study were:

Unknown Simulated Space – Thirteen VEs were created. The 13 VEs were ranged in scale from a simple space with only four walls to a complex space with three rooms. We chose this simple-to-complex-space scale to allow the user to gradually learn how to explore the VE by using the Phantom device and audio feedback and to learn about the system. Each space allowed us to focused on the main research questions while asking the participants to perform a variety of exploration tasks in the VEs.

The first and the second spaces were to train the participants on using and gathering information in the VE system using the Phantom device and audio feedback. The next six VEs were focused on exploring the haptic feedback. Each of these VEs included seven objects at a time randomly places within six VEs. This was done in order to eliminate bias. Each object included one of the three haptic properties: texture, stiffness, or a combination of both. A letter designated each object by audio feedback. The participants were asked to choose the three objects that were the user-

friendliest that they liked. It consisted of seven objects, three with only stiffness, two with only texture, and two with both stiffness and texture properties.

The next three VEs (VE 9-10-11) were focused on teaching and testing audio elements. Each VE included mono, stereo, or stereo with rotation as audio feedback. The participants were asked to explore the environment, and at the end of each task they were asked to describe verbally the environment and build a model of it using the model kit. After each session, the participants were asked questions about the audio feedback. VEs 12 and 13 included training on navigation tools and help keys. Additionally the participants were asked to describe verbally the environment and to build a model of it.

Exploration Task – Each participant was asked to explore the VE individually and without time limitations. The experimenters informed the participants that they would be asked to describe the room and its components at the end of their exploration.
In addition, a set of five instruments were developed for the collection of quantitative and qualitative data:

O&M Questionnaire – The questionnaire had 50 questions about the participant's O&M ability indoors and outdoors, in known and unknown environments. Some of the questions were adapted from O&M rehabilitation evaluation instruments for use in this study (e.g., a preschool O&M screening by Dodson-Burk and Hill, 1989; Lahav, 2003; and a rehabilitation evaluation by the rehabilitation center of the Israeli Lighthouse). The aim of this questionnaire was to evaluate the participant's O&M ability in a variety of real spaces and to find differences and similarities in their O&M experience and abilities.

Observations – The participant's exploration were video-recorded.

Open Interview – After completing the exploration task, the participants were asked to describe the space verbally. This open interview was video-recorded and transcribed.

Modeling Kit – A modeling kit was used by the participants to construct a model of the space.

Computer Log – The computer data enabled the researchers to track the user's exploration activities in the VE in two ways: as a text file containing precise spatial and temporal data and as a visual reconstruction of the participant's movements within the VE.
Procedure All participants worked and were observed individually. Each research participants was first asked to complete an O&M questionnaire. After they started to explore the VE, starting with VE 1 and finishing with VE 13. The tasks administered at this stage included free navigation in the VE. Following the exploration, the participants were asked to give a verbal description of the space and to construct a model of it. These sessions lasted about three hours.

Results

During the experiments the system components that allow people who are blind to work independently were tested. These features included navigation tools, audio feedback, haptic feedback, and help keys.

First Question: Which haptic feedback properties used in the VE strongly affected the participants?
In order to determine favorable haptic parameters, participants were made to explore a VE consisting of objects having different haptic characteristics. The VE consisted of three types of objects: objects with different stiffness properties; objects with different textures properties; and objects with a combination of both stiffness and texture properties. There were a total of 20 such objects with varied haptic properties. The participants were exposed to seven objects at a time (per VE), randomly chosen over six VEs. This was done in order to eliminate bias. In each VE, the participants were asked to feel each of the seven-labeled objects (identified to the participant by an audio file when they came into contact with the object) and then list the objects they felt most comfortable with. At the end of each session, each participant listed his or her three best object preferences. These results were then tabulated to determine the most preferable.

The objects with only stiffness properties were characterized by four parameters, namely: spring stiffness, a damping coefficient, static friction, and dynamic friction. These properties were varied to form seven objects. It was found that this type of object was most preferred by the participants (all seven objects of this type were listed

as preferable).

The objects with only texture properties were characterized by using a unit "bump" that was repeated over a line to develop a surface texture. There were two types of such bumps used. One was a saw tooth bump. These properties were varied to form eight objects. The other type of bump was a sine wave bump (Figure 2).

It was found that participants preferred objects with stiffness properties then texture properties. Participants preferred objects with texture properties only with large height (h) irrespective of the type of bump. However, combining the stiffness and texture properties mentioned in the paragraphs above formed the third type of object. These were again varied to form five objects. It was found that this type of objects were least preferred by the participants.

At the end of the experiment, the participants were asked to comment whether they preferred each VE components to be designated by a unique haptic feedback. All the participants mentioned that they preferred a limited number of haptic feedbacks, for example, different haptic feedbacks for wall, window, and door. When it comes to objects they preferred to have two: hard objects (e.g., table) and soft objects (e.g., sofa). Nevertheless, all the participants mentioned that as a result of a safety issue of area or objects (e.g., stairs, alarm door), they preferred to designate these components by unique rigid texture. Beside these unique components the participants preferred to keep the interaction simple with solid objects because it was less confusing and involved less information to gather. The ability to gather information by haptic and audio feedback simultaneously can lead to overload and be confusing. As a result all the participants used the Phantom for orientation and the audio feedback to gather information about the objects descriptions. J.: 'As soon I hear I'm touching something, I don't care what it feels like anymore.'

All the participants mentioned that the haptic feedback helped them to explore and navigate in the VE, and it helped them to trace the structure and object shape.

Second Question: *What are the audio feedback properties that maximizing the participants' exploration performance in the VE?*

The BlindAid includes audio feedback feathers that were tested during the experiments, for example, audio type, short or long component's description, hearcon versa audio-labeled and background sound. During the audio type experiments, each type of the audio feedback, such as mono, stereo, or stereo with rotation, were tested in different VEs. Three of the participants chose the stereo as an audio channel, and one chose the mono. The stereo gave them a sense of the ambient sound of the space helped them determine which direction to go in the map, and gave them more orientation to the overall space. Having the haptic feedback with the stereo audio feedback helped the user to remain in the absolute frame of reference. On the other hand, the stereo was an additional variable that they need to track, and the user continually needed to imagine his orientation at the time she or he heard the audio feedback. Our VE included only stable objects, so the stereo-rotation, which adds another level of complexity, was not needed.

Beside the type of the audio, the BlindAid included three types of audio feedback – hearcons, audio labeled, and background sound. Each component in the VE was designated by one or two audio feedbacks. The first level included a short and clear feedback (e.g., sound of a closing door), and the second level included a detailed description about the component (e.g., conference room). All the participants mentioned that the first level of audio feedback needs to be clear, recognizable, and short. If a hearcon is used, the hearcon needs to be clear and identify the components it represents without the need to learn and remember it. The VE components were divided by abstract components and non-distinguishable audio effect that were represented by an audio label (e.g., file cabin), or components that were easy to represent by hearcons (e.g., door). All the participants agreed on the way the component in the VE were represented by hearcons or labeled audio effects, and they liked the idea that there was another level of information on-demand. As result, the participants did not report overloaded by the audio effect or try to avoid interaction with the VE components. Usually after exploring the VE they repeatedly used the second level to gather more information about the VEs' components and to differentiate between them, for example to distinguish between "door number one" or "door number two."
The ability to have background sound (e.g., street noise) continuously with the stereo effect

was effective and needed. Similar to the rule of the background sound in real space, in the VE this background audio effect helped the users orient themselves in the space and use this component and location as a landmark.

Third question: *What are the useful properties of the exploration tools that maximizing the participants' exploration performance in the VE?*
The BlindAid system includes two navigation tools that help the participants during their VE exploration. These tools allow the user to move the VE workspace and install and recall landmarks. By using the arrow keys or the phantom button, the user could move his or her workspace. Each participant was trained to use both interfaces in two separate VEs. In the end of these two sessions, each of the four participants chose to use the phantom button. The use of the Phantom button was much more intuitive and a natural motion for the participants. By pushing the button they felt like the Phantom stylus was sticking to the surface and then they could move it over. It was more immediately associated with the white cane and gave them a sense of having some participation and control over movements. By using the Phantom button the participants did not have to take their hands of the phantom; they could get close to one of the VE components, drag it in the direction that they want to drag it, and then touch that object again. By using this strategy they confirmed where they thought they were. Additionally, by using the Phantom button they were able to drag the workspace at an angle, and not just drag left and right as by using the arrows keys. The system includes two types of landmarks – three landmarks that were installed by the researcher in advance and five landmarks that can be installed by the participant during his or her exploration in the VE. The user can recall these two types during the exploration stage. In a complex VE the participants used mostly their own landmarks, and they usually installed two of their own. The participants suggested that as a result of the landmark recall, the Phantom would take them to a particular landmark automatically, instead of just having an audio clue, or the landmark acted as a beacon.

Conclusion

The study reported here is part of a research effort aimed at understanding if and how the work with a VE supports the orientation skills of unknown environments by people who are blind. The participants preferred to maintain the haptic interaction simple with solid objects because it was less confusing and involved less information to gather. Having the haptic feedback with the stereo audio feedback helped the user to remain in the absolute frame of reference. On the other hand, gathering the information by haptic and audio feedback simultaneously add an additional variables that the participants need to track, and to imagine his orientation at the time she or he interact with the objects. Complex user interface, complex haptic and audio feedback can lead the participants to overload and confusing. Additional research and development efforts will transform this promising technology into useful diagnostic tool that will allow the researcher or the O&M teacher to be able to track and to observe how the participants are thinking during their exploration. Additionally, the BlindAid system can be use to train O&M teacher.

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The development of a paediatric pain management device

[ab]Kate Miller, [cd]Sam Bucolo, [d]Emma Patterson, [ab]Belinda Kipping, [ab]Roy M Kimble

[a]Royal Children's Hospital, Brisbane, Australia.
[b]University of Queensland, Brisbane, Australia
[c]Queensland University of Technology, Brisbane, Australia
[d]Diversionary Therapy Technologies, Brisbane, Australia

Kate Miller
Occupational Therapist/MPhil Candidate
UQ: Paediatrics & Child Health
Level 3 Foundation Building
Royal Children's Hospital
Brisbane QLD AUSTRALIA 4029
kate.miller@uq.edu.au
6170401260662

Abstract. *Childhood pain management has been a historical area of debate, and to date few advances have occurred that focus on pure paediatric models. Rather protocols have been developed to align paediatric non-pharmacological approaches with adult evidenced approaches. This is particularly evident with advancements made in technology based tools including virtual reality. This 'one size fits all' approach may be contributing to the varying degrees of clinical uptake of technologies into standard pain protocols. To ensure superior outcomes customisation is required to not only meet the developmental needs of children but also the clinical models and processes that the technology is to be integrated into. This customisation process is discussed, in terms of the development of a paediatric specific pain management tool; Multi modal Distraction (MMD), in this paper.*

Preliminary results of randomised clinical trials in the paediatric burns population are indicating significant trends ($p<0.05$) in pain reduction and length of treatment when children have access to the MMD device. These trends alongside clinician feedback about its positive impact on clinical processes, and potential for uptake imply the customisation process is successful.

Key words. *Pain, pain management, distraction, virtual reality, multi modal distraction*

Introduction

Issues of childhood pain and pain management are currently an important area of research as healthcare priorities focus on preventative illness including ensuring healthier beginnings for children to reduce future chronic health issues (Australian Research Council, 2008). Studies have shown morbidity associated with negative pain experiences in the first 10 years of life can impact well into adulthood(Von Baeyer, Marche, Rocha, & Salmon, 2004). The short term impact of poorly managed pain include; functional disturbance of feeding and sleeping, and difficulty with behavioural regulation (Anand & Hickey, 1987; Marshall, Stratton, Moore, & Boxerman, 1980). The longer term implications include; reduced coping abilities, anxiety, depression, post traumatic stress disorder and hypersensitivity of the nervous system to pain (Stoddard et al., 2006; Weisman, Bernstein, & Schechter, 1998). Pain is subjective and is acknowledged that due to developmental milestones all children will experience, remember and deal with pain differently (McMahon & Koltzenberg, 2006). Given this understanding and the possible consequences of poorly managed pain, it is not enough to take a 'one size fits all' approach to pain management.

Current literature recommends a combined pharmacological and non-pharmacological approach to pain management (de Jong, Middelkoop, Faber, & Van Loey, 2007; Foertsch, O'Hara, Stoddard, & Kealey, 1998). Despite this evidence, most acute centres still regard non-pharmacological approaches as adjunct, rather than protocol. This lack of clinical uptake is concerning, and insight is required into why this so, to improve the approaches and therefore increase uptake into practice. These ongoing challenges faced by historical approaches have offered future non-pharmacological advancements a strong platform for development, particularly in the technology field. Technology has the ability to

offer approaches that can be flexible to meet individual healthcare models, adapted to fit clinical processes and developmental needs. This could ensure new technology approaches are accepted as essential practice rather than adjunct by making its uptake and use easier and more effective than current practices.

The application of technologies to the management of physical, psychological and social health issues continues to be reported internationally (Difede & Hoffman, 2002; Rizzo et al., 2005; Walshe, Lewis, Kim, O'Sullivan, & Wiederhold, 2003). Of particular interest are the innovations of virtual related technologies (VR) aimed at non-pharmacological pain management during acute treatment procedures (Chan, Chung, Wong, Lien, & Yang, 2007; Das, Grimmer, Sparnon, McRae, & Thomas, 2005; Hoffman, Patterson, Carrougher, & Sharar, 2001; Mott et al., 2008). A growing body of evidence is establishing VR's superiority in reducing procedural pain in adults. With these significant outcomes it would seem logical to adapt these technologies into paediatric protocols to ensure best pain management practice across the life span (Das, Grimmer, Sparnon, McRae, & Thomas, 2005; Hoffman, Patterson, Carrougher, & Sharar, 2001). However this adaptation process, to meet developmental needs is more difficult than previously established. Studies that utilize similar technology and content in both adults and children negate any impact development and experience brings to the understanding and management of pain issues (Miller, Bucolo, Patterson, & Kimble, 2008).

Technology, including VR, could be a great medium for pain management but the processes involved in the development of the technology needs to be inclusive, developmentally appropriate and customised to ensure not only significant outcomes but also uptake within a healthcare environment. It is worth noting that while VR has been extensively used in research, its uptake into daily standard clinical protocols is limited internationally. It may be implied that like many previous approaches and healthcare innovations, the design processes have miss-matched the technology with clinical healthcare models, processes and the users.

This paper aims to discuss the inclusive customisation process used in the development of a paediatric distraction tool, Multi Modal Distraction (MMD), and the scientific evidence that supports the process, so that it may be applied to all future health based technology innovations to ensure greater uptake and therefore quality of care.

The Inclusive Customisation Process

In design, the process of customisation is the practice of taking an idea and tailoring it to suit the needs of; (i) the investor, stakeholders within the governing of hospital processes; (ii) the initiators, hospital staff involved in prescribing treatment to the child and (iii) the users, in this case the child requiring a painful procedure and the staff administering the treatment (Chakravorti, 2004; Kimaro & Twaakyondo, 2005). Without this process new innovations fail to be integrated into standard practice due to reservations, of staff, about there actual usefulness compared to current practices, the time and processes required to change practice and the 'actual' potential to impact upon their clinical role (Ball et al., 2008; Kimaro & Twaakyondo, 2005). Uptake has proven to be effective when all parties involved with the use of technology are considered, and even where possible consulted. This process ensures that the device meets a need, enhances current practices (rather than replacing a role, or making practices more difficult), is intuitive and therefore offers the clinician and the child a device that distracts whilst fitting into current practices (Bauer, Lane, Stone, & Unnikrishnan, 1998; Bucolo, Mott, & Kimble, 2006; Chakravorti, 2004; Quinn, Doorley, & Paquette, 1990). It is these principles that were considered in the development of a paediatric MMD device, being prototyped and trialled with children undergoing burns procedures in an acute healthcare facility (Bucolo, Mott, & Kimble, 2006; Miller, Bucolo, Patterson, & Kimble, 2008).

The five steps considered in customising MMD were (1) Perspective (2) Collaboration (3) Application to technology (4) Trials and Testing, and (5) Review. These will be discussed in the MMD example below where both content and console development are considered within this framework.

MMD Content & Console Development

Perspective. *This step involves understanding the current healthcare setting, clinical processes and protocols, models of service delivery and what gaps exist that impact upon efficacy and efficiency of a service.*

The emergence of MMD has been discussed in a previous paper (Miller, Bucolo, Patterson, & Kimble, 2008). Its innovation came from a perceived gap in the availability of appropriate technology based pain management for younger children, and also in the customisation of technology to meet health practice (Bucolo, Mott, & Kimble, 2006; Miller, Bucolo, Patterson, & Kimble, 2008). The acute clinical environment sets up many boundaries for the content and console development of MMD. The initial step was to gain a perspective about how technology would fit into a paediatric health care model, and what the barriers to implementation were. The concepts of evidenced based practice, time and staff efficiency, attitudes about its use and usefulness and cost were some of the important knowledge gained from this process. This step also gave insight into the difference between hospitals in terms of processes, patients (language spoken) and treatments used. Therefore the device needed to be adaptable to meet individual hospitals needs. This allowed a process of continued collaboration to be set up to ensure each of these critical areas were explored and used to develop MMD.

Collaboration. *Discussion and planning with key stakeholders is one of the most important steps.*
Collaboration occurred continuously throughout the MMD development in many ways, including (1) face to face discussion with clinical staff including nurses, allied health and consultants. These discussions allowed for an understanding of what these key stakeholders would find useful, what criteria the device did and did not meet to ensure easy uptake by staff, what they have seen work effectively with children. (2) Children were asked to fill in usability questionnaires regarding the prototypes. Information was gained about both the console and content, what was easy/hard, interesting/boring and what they would do to change the device. And (3) parents were engaged and asked for feedback in terms of the engagability of the device, whether their child appeared interested and what changes they would make. This information combined with the available literature was essential in the production and refining of MMD.

This collaboration gave guidelines around clinical processes that the device needed to 'fit' with. For example the device had to be user friendly, so that staff did not have to set up the device or assist the child to interact. This would improve efficiency of their work. Staff would not work with bulky equipment, where chords may impact upon treatment. The device had to be useable during all treatment, regardless of where they were receiving that treatment (e.g. in the burns bath) or their position (e.g. prone).

In considering the consumer, the child, and their ability to interact with the console it was important to consider the physical and cognitive abilities of the 3- 10 years age group. Staff consulted on how these milestones impact upon pain experiences and how children are appropriately distracted. The principles used for child specific content came from an understanding of what engages and creates continuous distraction in younger children. It was acknowledged by all stakeholders that distractions work differently for individual children.

Application to Technology. *The next step focuses on the design and development of the technology.*
With the understanding of what clinical and developmental needs were required, the content and console were designed and adapted. In designing the console the following alterations were made to ensure usability. The device was voided of all chords to reduce safety hazards and keep the workplace clear for access. The outer console was made to waterproofing standards to ensure its use by all children undergoing a variety of treatments. Currently most technology based distractions do not meet infection control standards. MMD overcame infection control problems by ensuring the outer case was structured to allow for standard infection control cleaning procedures. The console was contoured to ensure children could use it regardless of their treatment position, including usability with one hand. Gross movements are used for interaction so that younger children can manipulate it.

In terms of content, the development of the "bobby got a burn" preparation story occurred in collaboration with the clinicians, and came from both literature and clinical experience suggesting it usefulness in reducing procedural pain. This story is used in waiting rooms to ensure access to preparatory information by all children. MMD offers children a choice between stories, games and movies. It is acknowledged that choice is an important developmental milestone for this age group, who seek control particularly during treatment procedures where control and involvement is limited. The stories are levelled, with difficulty

increasing as the child moves through the scenes. This assisted in allowing content to be accessible by both younger and older children. Touch screen is the primary interaction, another important modification to reduce the fine motor precision required to interact. The multi-sensory input was the key in ensuring continuous distractibility to reduce habituation. Visual, auditory (in a variety of languages) and vibration are the core stimulus used throughout interaction with content. The use of ear phones was an addition by clinical staff who suggested the child may be disturbed by external noise.

Testing & Trials. This is an essential step in assessing whether the integration and collaboration process has been successful in developing a product that is improving outcomes and fitting into everyday clinical practice.

The above process of MMD evolvement discussed how readily technology can be adapted to meet user needs and clinical processes to ensure better uptake. However healthcare is an outcome based industry that will ask the question: Does the process of customisation and collaboration ensure its efficacy in managing procedural pain, and actual uptake of its use into standard practice? Although the literature suggests the answer is yes, clinical trials are needed to base clinical decisions and treatment on best evidence that has been tested in the real setting.

Clinical trials have continued throughout MMD development. The core aims of these trials were to determine (1) efficacy on pain reduction and (2) qualitative feedback to ensure inclusive collaboration and customisation (Mott et al., 2008). The current clinical trials being completed are aimed specifically at providing generalisable evidence to support MMD's use with managing paediatric burn pain through preparation and distraction. These trials are locally and internationally based to ensure it takes in the scope of culture, language and clinical practice. These results and longer term follow up, following commercialisation of MMD in 2009, will determine whether customisation is the answer to ensuring uptake of clinical technologies. The methodology of the trials was established to reduce frustration with current literature that reports outcomes based on limited samples, study design and outcome measures.

Randomised control trials within the local burns centre are just being completed (n= 75, aim is for 80). Results are indicating trends that show despite age, depth and TBSA of a burn injury, MMD is ensuring reduced pain observations (nurse and caregivers) and reports (child) compared to television, videogames and toys ($p<0.05$). Reduced treatment lengths are also being indicated with the use of MMD over standard practices and video games ($p<0.05$). Clinician feedback is suggesting a greater likelihood of uptake and acceptance into healthcare models due to the collaborative processes that are ensuring a better clinical fit compared to other technology based devices.

Review. This process is continuous with trials and testing.

Focal customisation of MMD has occurred with the upgrade between prototypes, specifically between the latest (P4) to (P5) upgrade. Clinical trials, observations and ongoing feedback have acknowledged what is required by clinical processes, clinicians, and users to ensure MMD's effectiveness and usability. An international multicentre trial is set to commence with the P5 prototype mid 2008 to review the efficacy of the adaptations made to the prototype and to ensure generalisability to a wider paediatric population.

Conclusion

The evidence suggests that taking a technology only approach to the design and implementation of advanced pain management technologies into healthcare models is ineffective in ensuring efficacy and uptake clinically across the lifespan. An inclusive customisation process, including technology design combined with clinical consultation and user needs is a more holistic process in achieving not only better outcomes for the user but also a better clinical fit to support its uptake into daily clinical processes. Technology advances have been neglected in the paediatric pain field, and no longer is the integration of adult models into childhood protocols appropriate. This paper discussed the design and customisation processes involved with MMD development. Trials and clinician feedback are confirming greater procedural pain reduction due to the consideration of user needs, in the MMD design and are also indicating easy uptake of the device into clinical healthcare models and processes. With more in-depth deign principles and customisation of available technology, as demonstrated by MMD development, patients and clinicians will

have daily access to more advanced treatment approaches and therefore a greater impact on reducing the short and long term implications of the pain experience discussed.

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Virtual reality on mobile phones to reduce anxiety in outpatient surgery

[1]José Luis Mosso, [2,3]Alessandra Gorini, [1]Samuel Senties, [1]Gustavo de la Cerda, [1]Gabriela López, [4]Verónica Lara Vaca, [2]Giuseppe Riva

[1]Hospital General y Regional No. of the IMSS, Mexico
[2]Istituto Auxologico Italiano, Milan, Italy
[3] Research Institute Brain and Behaviour, Maastricht University, The Netherlands
[4]Hospital de Ginecología y Obstetricia Unidad Tlatelolco del IMSS

Corresponding author: alessandra.gorini@gmail.com

Abstract: *When undergoing ambulatory surgical operations, the majority of patients experience high levels of anxiety. Different experimental studies have shown that distraction techniques are effective in reducing pain and related anxiety. Since Virtual Reality (VR) has been demonstrated as a good distraction technique, it has been repeatedly used in hospital contexts for reducing pain in burn patients, but it has never been used during surgical operations. With the present randomized controlled study we intended to verify the effectiveness of VR in reducing anxiety in patients undergoing ambulatory operations under local or regional anaesthesia. In particular, we measured the degree to which anxiety associated with surgical intervention was reduced by distracting patients with immersive VR provided through a cell phone connected to an HMD compared to a no-distraction control condition.*
A significant reduction of anxiety was obtained after 45 minutes of operation in the VR group, but not in the control group and, after 90 minutes, the reduction was larger in the experimental group than in other one. In conclusion, this study presents an innovative promising technique to reduce anxiety during surgical interventions, even if more studies are necessary to investigate its effectiveness in other kinds of operations and in larger numbers of patients.

Introduction

In the last 50 years there have been significant advances in anaesthesia and surgical methods, which have created the possibility of performing procedures with greater precision, predictability, speed, safety, and often without pain. However, despite these progresses, a common problem that still involves surgical operations using local or regional anaesthesia is that a lot of patients experience high levels of anxiety before and during the operation, since they usually do not know enough about medical procedures and they presume that such procedures will cause them pain and discomfort. Local and regional anaesthesia are techniques used to render part of the body insensitive to pain without affecting consciousness; this means that during the operation patients can perceive everything is happening around them: they can see doctors and nurses moving around, hear their voices and comments and so on. Patients with high levels of anxiety usually perceive the procedure more distressing than it really is. This causes a lack of cooperation during the operation, which in turn may cause stress on the operating surgeon, impairing his or her surgical performance and leading to longer operative times. Moreover, in the worst cases, patients demonstrate their avoidance behaviour by not attending their appointments.

Different experimental studies have shown that cognitive factors such as attention can influence the subjective experience of pain and fear of pain (Andrasik, Flor, & Turk, 2005; Eccleston & G., 1999; Melzack & Wall, 1965). In particular, distraction techniques have been demonstrated to be effective in reducing pain and related anxiety (Fernandez & Turk, 1989; Tan, 1982). Unfortunately, these techniques have been primarily used in artificial context such as research laboratories and their effectiveness may not be generalized to more complex clinical settings. Moreover, the more complex and uncontrollable the critical situations, the more difficult it is to obtain an effective distraction. For these reasons it is necessary apply distraction techniques, effective in different contexts and clinical procedures.

Hoffman and coll. have recently shown the potential of immersive virtual reality (VR) in reducing pain during the wound caring on conscious patients with severe burn injuries ,which is widely considered one of the most painful medical pro-

cedures (Hoffman, 2004; Hoffman, Patterson, & Carrougher, 2000; Hoffman, Patterson et al., 2004; Hoffman et al., 2008; Hoffman et al., 2006; Hoffman et al., 2007; Patterson, Hoffman, Palacios, & Jensen, 2006; Sharar et al., 2007). The illusion of going into the 3-dimensional computer generated world (known as presence) provoked by VR immersion is thought to be especially effective in moving attention away from the real world situations to the virtual environment. Researchers have demonstrated that patients who experience a stronger illusion of going into the virtual world representing an icy, cool 3-dimensional virtual environment (the SnowWorld) will be more distracted by VR, and will thus report more pain reduction than those who experience a less compelling illusion of presence in the virtual world (Hoffman, Sharar, & Coda, 2004). VR has also been used for reducing anxiety and stress in individuals exposed to critical real-life situations, such as university students performing examinations (Riva, Grassi, Villani, Gaggioli, & Preziosa, 2007) and commuters travelling every day in very uncomfortable situations (Riva, Preziosa, Grassi, & Villani, 2006). Also in these cases, a relaxing VR environment helps subjects to move their attention from a disturbing condition to a relaxing experience.

Immersive VR can be provided using a computer or an advanced personal digital assistant (PDA) or mobile phone (Preziosa, In press) connected to an head mounted display (HMD), a display device worn on the head or as part of a helmet that allows a stereoscopic vision. The HMD blocks the user's view of the real world, and, on the contrary, presents patients with a view of a computer generated world. The helmet and headphones exclude sights and sounds from the hospital environment, providing converging evidence from the virtual world to multiple senses (both sight and sound). VR has been repeatedly used in hospital contexts for reducing pain in burn patients, but it has never been used during surgery. With the present randomized controlled study we intended to verify the effectiveness of VR in reducing anxiety in patients undergoing ambulatory operations under local or regional (epidural) anaesthesia. Using a controlled experimental design, we tested the degree to which anxiety associated with surgery was reduced by distracting patients with immersive VR compared to a no-distraction control condition. In many cases this kind of operation provokes moderate pain and high level of anxiety, associated to physiological responses such as increasing of blood pressure and heart rate that can interfere with the surgical procedures. These symptoms are usually reduced with medical treatments that increase operation costs and often produce side effects. The other relevant innovation of this study regards the introduction of mobile phones in the operation room. Patients will be immersed in a relaxing environment wearing an HMD connected to a small Nokia phone. No computers, neither big screens or projections, are necessary to provide patients with VR.

Method

Subjects

Twenty one patients, 14 females and 7 males, aged between 17 and 81 years (mean = 49.6 ± 18) participated in the study. All patients underwent an ambulatory surgical operation at the General and Regional Hospital No. 25 of the IMSS in Mexico City (for a detailed list of the performed operations see tab.1). Patients were randomly divided in two groups: the experimental group (N = 11; 8 females and 3 males; mean age = 44.4 ± 13.5) and the control group (N = 10; 6 female and 4 males; mean age = 55.4 ± 21.2). The age difference between the two groups was not significant.

Immediately before the operation, patients included in the experimental group were instructed about the use of the HMD and VR and were asked to sign an informed consent.

Technical equipment

- Nokia N95: a mobile phone with up to 160 MB of internal memory. *Display*: Large 2.6" QVGA (240 x 320 pixels) TFT display with ambient light detector and up to 16 million colours. *Operating system*: Symbian OS; User Interface: S60 3rd edition; Dedicated Media Keys; Multimedia Menu. *Mobile video*: Video resolutions: up to VGA (640x480) at 30 fps; video clip length: limited by available memory; video file format .mp4. *Music features:* Digital music player - supports MP3/ AAC/AAC+/eAAC+/WMA/M4A with playlists and equalizer; Integrated handsfree speaker. *Connectivity*: USB 2.0 via Mini USB interface and mass storage class support to support drag and drop functionality; Nokia PC Suite connectivity with USB, Infrared and Bluetooth wireless technology.
- HMD Vuzix iWear AV 920: Twin high-resolution 640x480 (920,000 pixels) LCD

Case Number	Group	Sex	Age	Anesthesia	Surgery
Case 1	Experimental	Female	50	Local	Close surgical injury
Case 2	Experimental	Female	47	Local	Lipoma resection
Case 3	Experimental	Female	30	Local	Cyst resection
Case 4	Experimental	Female	45	Local	Lipoma resection
Case 5	Experimental	Male	45	Regional	Inguinal Hernia repair
Case 6	Experimental	Male	17	Regional	Inguinal Hernia repair
Case 7	Experimental	Male	36	Regional	Inguinal Hernia repair
Case 8	Experimental	Female	47	Regional	Epigastric hernia
Case 9	Experimental	Female	67	Local	Lipoma in abdomen wall
Case 10	Experimental	Female	45	Local	Lipoma in Jambe
Case 11	Experimental	Female	60	Regional	Left ing. Hernia repair
Case 1	Control	Female	36	Local	Nodules on the head
Case 2	Control	Male	48	Local	Left ing. hernia
Case 3	Control	Male	73	Local	Tenkoff catheterinstallation
Case 4	Control	Female	33	Local	Inguinal hernia
Case 5	Control	Female	59	Local	Umbilical hernia repair
Case 6	Control	Male	24	Local	Gynecomastia resection
Case 7	Control	Female	86	Local	Big umbilical hernia repair
Case 8	Control	Male	47	Regional	Left inguinal hernia
Case 9	Control	Female	67	Local	Lipoma in abdomen wall
Case 10	Control	Female	81	Regional	Umbilical hernia repair
Case 11	Control	Male	77	Regional	Left ing. Hernia repair

Tab.1: Epidemiological and clinical characteristic of the sample

displays equivalent to a 62" screen viewed from 9 feet; iWear® 3D enabled for automatic 2D/3D control; no buttons required; Visor weighs 2.9 ounces; Can be worn with or without prescription eyeglasses; Removable, integrated speakers that can be upgraded or removed to allow you to plug in your own headsets; AccuTilt™ viewer pivots up to 15 degrees for comfortable viewing angle; Soft, comfortable, hypo-allergenic nosepiece extends up to 3/8"; Custom fit headstrap; Integrated rechargeable lithium ion battery allows approximately five hours of continuous operation; 60 Hz progressive scan update rate.

Virtual environment
A pre-recorded video of the Green Valley, a very relaxing environment showing a mountain landscape around a calm lake is presented together with the relaxing music and soft sounds (birds' songs, water flowing, etc) (see fig.1). Patients have the impression to walk around the lake, they can observe the nature and virtually sit on a comfortable deck chair, in order to become easily relaxed.

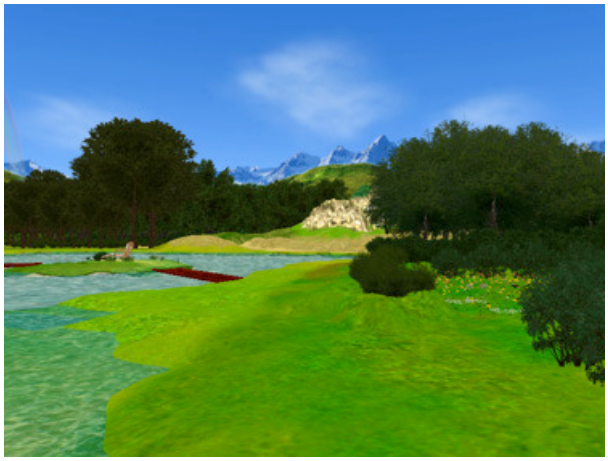

Fig.1: A screenshot from the Green Valley

Measures of anxiety
The patients' self-ratings of anxiety were the primary dependent variables. Ratings were administered immediately before (T0), after 45 minutes (T1) and after 90 minutes of operation (T2). Measurement at T1 and T2 were taken during a brief (approximately 2 minutes) pause in operation. Patients gave ratings using 0-10 visual analogue scale for anxiety (VAS-A) (see fig.2).

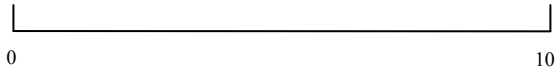

Fig.2: VAS-A. Patients were asked to answer the following question: Please indicate how much anxiety you are experiencing now (0 is no anxiety at all, 10 is the maximum level of anxiety you can experience)

Experimental procedure
Patients in the experimental group wore the HMD and the headphones connected to the Nokia N95 few minutes before the anaesthetic injection (see fig.3).
The total length of the virtual relaxing presentation was 90 minutes- that was more of less the duration of the intervention.
Patients in the control group did not receive any kind of virtual exposure.

(a)

(b)

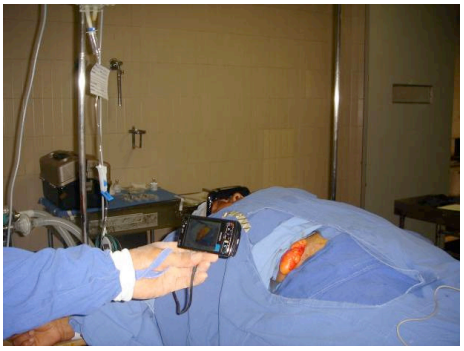

Fig.3: (a) Cyst resection on the head; (b) Lipoma resection on the abdomen wall

Results

At T0 all patients were asked to rate their level of anxiety on a scale of 0-10. Statistical analysis show that the level of anxiety did not differ between the two groups ($t = 0.547$, $df = 19$, $p = 0.59$). After 45 minutes the anxiety level significantly decreased in the VR group ($t = 3.57$, $df = 10$, $p < 0.05$), but not in the control group ($t = 0.73$, $df = 9$, $p = 0.48$), while after 90 minutes it decreased in both groups ($t = 4.74$, $df = 10$, $p < 0.01$; $t = 2.37$, $df = 9$, $p < 0.05$) (see fig.4). Moreover, comparing the two groups, we observed that the reduction of anxiety between T0 and T2

was higher in the VR group (mean: 5.27 ± 3.69) than in the control group (mean: 2.2 ± 2.94) ($t = 2.1$, $df = 19$, $p < 0.05$).

No differences were found in anxiety reduction between males and females ($t = 1.39$, $df = 19$, $p = 0.18$). No correlations were found in the two groups between age and the decrease of anxiety (VR group: $r = -0.115$, $n = 11$, $p = 0.735$; control: $r = 0.36$, $n = 10$, $p = 0.31$).

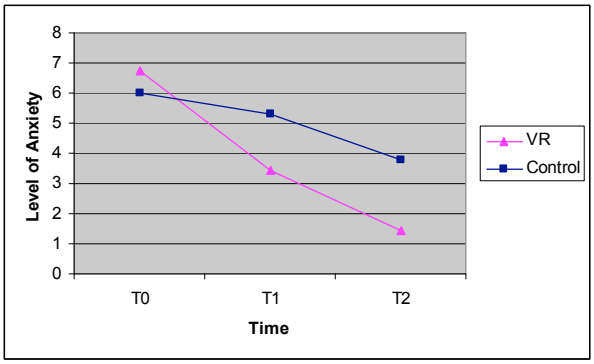

Fig.4: The graph represents the decreasing of anxiety along time in the two groups of patients

Discussion

The present study provides preliminary evidence that entering a virtual relaxing environment can help to reduce anxiety during surgical interventions performed under local or regional anaesthesia. A significant reduction of anxiety was obtained after 45 minutes of operation in the VR group, but not in the control group and, after 90 minutes, the reduction was larger in the experimental group than in other one. These results can be explained by the positive effect of virtual immersion on relaxation, and not only by the fact that patients realized that the operation was going to be concluded. Moreover, the lack of correlation between age and anxiety decrease means that VR exposure is equally effective in all patients, no matter how old they are.

VR systems provide computer-generated sensory inputs to several senses (in our case sight and sound) which make the presented virtual world difficult for the brain to ignore. Inducing the illusion of going into the virtual environment, immersive VR is more effective than other cognitive methods in distracting patients from their worries. Moreover, differing from other forms of distraction, the HMD prevents patients from looking at the real world. The impossibility to see the doctors and the surgery room may be one important advantage of VR. In a surgical setting, reduction of anxiety is important for different reasons: (1) patients undergo operation in a more relaxed way; (2) their physiological parameters remain more stable during the intervention; (3) no extra pharmacological medications are needed in order to calm patients. With VR we can obtain these advantages without side effects, using very small and easy to install equipment. Since these data demonstrate that even small cell phones are suitable for VR immersion, in the future studies we are going to provide them to the patients before operations. We intend to give patients the possibility to practice relaxation abilities in a non-immersive way (without the HMD) with the same virtual environment they will see during the operation in order to help them to become more quickly and easily relaxed.

The substantial limitations of this study are the quite small sample size, the lack of a blind experimental condition and the lack of the possibility to actively interact with the virtual environment. The latter feature could be relevant to increase the sense of presence, that is the impression to be immersed in the virtual environment, but it is difficult to be introduced in a surgical setting where patients are usually lying down and asked not to move.

In conclusion, this study presents an innovative and promising technique to reduce anxiety during surgical interventions, even if more studies are necessary to investigate its effectiveness in other kinds of operations and in larger numbers of patients.

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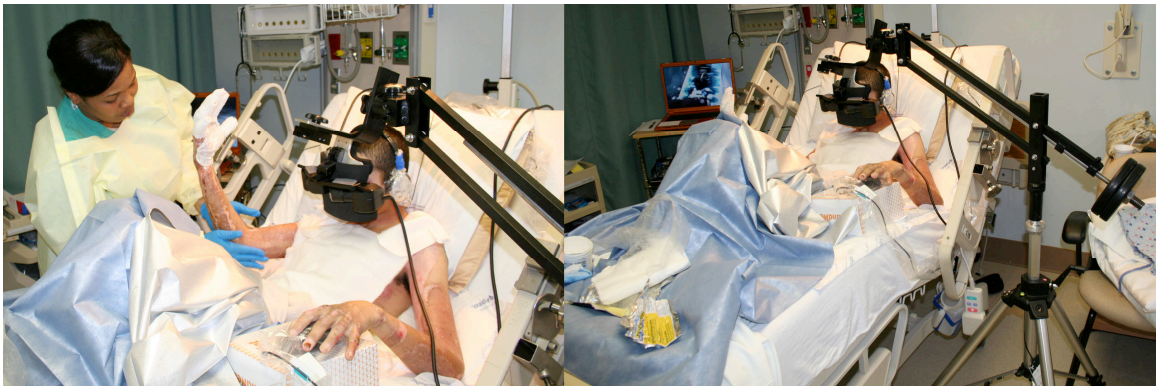

Figure 1. U.S. Army soldier receiving VR exposure therapy to reduce his pain during severe burn wound care, using a unique articulated arm mounted VR goggles that hold the displays near the patient's eyes. Photos and copyrights Hunter Hoffman, U.W.

weightlessly, eliminating the need for the patient to put on a VR helmet and reducing the amount of surface contact needed with the patient (see Figure 1).

Subject

Patient 1 was a U.S. Army soldier medically evacuated from Iraq to USAISR after suffering severe burns covering 32% of his body approximately 45 days prior to this intervention. While a passenger in a vehicle that was attacked by an improvised explosive device (roadside bomb), he experienced full thickness burns on his hands, arms, anterior and posterior chest and distal thighs. In the following weeks, donor skin

Figure 2. A Snapshot of SnowWorld (the virtual world burn patients interact with during wound care). Image by worldbuilder Ari Hollander, www.imprintit.com, copyright Hunter Hoffman, UW., www.vrpain.com

Stroke rehabilitation using the Rehabilitation Gaming System (RGS): initial results of a clinical study.

Mónica S. Cameirão[1,], Sergi Bermúdez i Badia[1], Esther Duarte Oller[2], and Paul F.M.J. Verschure[1,3]*

[1]Laboratory of Synthetic Perceptive Emotive and Cognitive Systems (SPECS), Institut Universitari de l'Audiovisual (IUA), Universitat Pompeu Fabra, Barcelona, Spain
[2]Servei de Medicina Física i Rehabilitació, Hospital de L'Esperança, Barcelona, Spain
[3]Institució Catalana de Recerca i Estudis Avançats (ICREA), Barcelona, Spain

** Corresponding author: monica.cameirao@upf.edu*

Abstract: *In the last few years, Virtual Reality (VR) has shown to be a promising tool in neurorehabilitation that can be used to diagnose, monitor and induce functional recovery after lesions to the nervous system. We developed the Rehabilitation Gaming System (RGS), a VR tool for the rehabilitation of motor deficits of the upper extremities. This system combines movement execution with the observation of a correlated action by virtual limbs that are displayed in a first-person perspective. We hypothesize that through this visual-motor pathway we can promote cortical reorganization and enhance recovery following a lesion in the brain.*
The RGS is a multi-level adaptive tool that provides a task oriented training of graded complexity that is online adjusted to the capabilities of the patients. In addition, this system retains qualitative and quantitative information of the performance of the patient during the tasks, allowing for a detailed assessment of the deficits of the patients. We believe that all these properties make the RGS an appropriate tool for rehabilitative training. The RGS is currently being used in a randomized clinical study with two control conditions. Although at this moment the sample size is too small – only 2 patients completed the entire protocol – to draw final conclusions, we expect our system to have an impact in functional motor recovery, as well as in the management of daily living.

Introduction

In the last decade several Virtual Reality (VR) systems have been developed for the rehabilitation of motor deficits, with special emphasis in arm rehabilitation following stroke (see (Cameirao, Bermudez i Badia, & Verschure, 2008) and (Holden, 2005) for reviews). It is estimated that stroke is and will be one of the main causes of burden of disease during at least the next 20 years (Mathers & Loncar, 2006), and consequently there is a need to develop efficient rehabilitation strategies. Following a stroke recovery is possible by means of cortical plasticity, meaning that the surrounding areas of the lesion or the contralateral hemisphere take over lost functionality (Fisher, 1992; Nudo, Wise, SiFuentes, & Milliken, 1996). Therefore, rehabilitation after stroke mainly focuses in maximizing this effect. Different approaches can be found based on specific hypotheses such as intensive rehabilitation (Kwakkel et al., 2004), tasks directed training towards specific deficits (Krakauer, 2006), mirror therapy (Altschuler et al., 1999), constraint-induced movement therapy (Blanton, Wilsey, & Wolf, 2008), motor imagery (Gaggioli, Meneghini, Morganti, Alcaniz, & Riva, 2006), action observation (Ertelt et al., 2007), etc. Here we can also find VR methods that often follow several of the above mentioned rehabilitation strategies. A number of studies point out the benefits of VR in stroke rehabilitation, suggesting an increased impact on recovery (Cameirao et al., 2008; Holden, 2005). However, the quantification of the effects of VR systems in patients and the understanding of the different parameters of the system is still very anecdotal. There is a need for developing scenarios that are not only based on the knowledge of the mechanisms of recovery, but that also take into account the individual responses of the subjects to the virtual task in order to deploy an optimal and individualized training.

We are investigating the impact of VR methods in stroke patients using the Rehabilitation Gaming System (RGS), a VR system for the rehabilitation of the motor deficits of the upper extremities (Cameirao, Bermudez i Badia, Mayank, Guger, & Verschure, 2007; Cameirao, Bermudez i Badia,

Zimmerli, Duarte Oller, & Verschure, 2007). This system combines movement execution with the observation of correlated actions of virtual limbs that are displayed in a first-person perspective. We hypothesize that within such a scenario we can promote cortical reorganization and enhance and/or speed-up recovery. This could be achieved through the activation of undamaged primary or secondary motor areas (August et al., 2006), recruiting alternative motor networks such as the mirror neuron system (Rizzolatti & Craighero, 2004). In addition, the RGS has the advantage of offering a rehabilitative training that is online adapted to the capabilities of the patients. Moreover, it proposes tasks of different complexity at different stages of the rehabilitation period, and it allows a continuous quantitative monitoring of the patient over time. In a first study of the RGS with stroke patients we investigated performance and the transfer of movement deficits between real and virtual tasks (Cameirao, Bermudez i Badia, Zimmerli et al., 2007) and the effect of different task conditions on stress and arousal measurements (Cameirao, Bermudez i Badia, Mayank et al., 2007). We observed that our system retains qualitative and quantitative information of the patient's performance during the tasks, allowing for a detailed assessment of a patient's deficits.

The RGS is currently being used in the Hospital de L'Esperança in Barcelona for the rehabilitation of acute stroke patients in a randomized study with controls. Here we review the main properties of the RGS and report on some of the first results of the clinical study.

Methods

Experimental Apparatus

The Rehabilitation Gaming System is composed by a PC with graphics accelerator, a 19 inches LCD display and a color CCD camera (Figure 1). The camera positioned on top of the display allows tracking color patches in specific points of the upper extremities (elbows and wrists) using a vision based motion capture system (AnTS) (a more detailed description of the tracking system can be found elsewhere (Cameirao, Bermudez i Badia, Zimmerli et al., 2007)). Finger flexion/ extension is captured by means of 5DT data gloves (Fifth Dimension Technologies, Pretoria, South Africa) that use optic fiber technology to measure finger bending. The captured movements are mapped in real time onto the movements of a virtual character, which is rendered in a first-person perspective. The Torque Gaming Engine was chosen for the implementation of the game scenarios (www.garagegames.com). Thus, on the screen the user observes two virtual arms that move accordingly to his/her movements.

The basic virtual environment consists of a game where flying spheres move towards the user and have to be intercepted using the virtual arms. The difficulty of the task is modulated by the speed of the spheres, interval of appearance between consecutive spheres and the range of dispersion in the field of view. These parameters are computed in such a way that we adapt the difficulty of the task to the individual performance of the subject. Moreover, the proposed task has graded difficulty and specificity: a 'Hitting' task to train range of movement and speed; a 'Grasping' task to train finger flexure; and finally a 'Placing' task to train grasp, displacement and release. These tasks are sequentially presented to the patients at specific time periods during the study.

The task is always preceded by an evaluation phase that allows measuring the reaching distance, precision and speed of arm movements in real and virtual worlds (Cameirao, Bermudez i Badia, Zimmerli et al., 2007). First, the subject is asked to touch a sequence of targets marked on the table surface in a specific order. Second, the subject is asked to perform the same task in the virtual world using the virtual arms and a virtual replica of the table with the targets.

Figure 1. The Rehabilitation Gaming System. A subject faces a display with the arms resting on a table. The arm movements are tracked by a camera positioned on top of the display. The tracking system detects in real-time the position of the color patches located on the wrists and elbows. Data gloves are used to detect finger movements. This way, on the display two virtual arms reproduce the movements of the subject's arms.

Study Protocol

The clinical study with stroke patients includes three different therapy conditions: the RGS group and two control conditions. Patients are randomly assigned to one of the three groups. For the first control group (Control A), the effect of the virtual visual stimulus is removed. Here subjects perform motor tasks as the one promoted by the RGS, but in the absence of the VR system. The tasks are performed on a table and include object manipulation, grasping and placement with increasing complexity. The second control group (Control B) controls for computer use and gaming effect. The subjects of this group perform non-specific games with the Nintendo Wii (Nintendo, Tokyo, Japan) which require upper limb motor control.

Each subject follows a 3 month program, with 3 weekly sessions of 20 minutes. The patients in the control groups perform the "real" evaluation phase of the RGS once per week. Thus, we also record quantitative information on the properties of the movements (range of movement, speed and precision) for these patients. Clinical evaluation of function is performed at admittance, at session 15 (approximately 5 weeks after the beginning of the study), month 3 (end of the program) and month 6 (follow-up). The evaluation scales include among others the Functional Independence Measure (FIM) (Keith, Granger, Hamilton, & Sherwin, 1987), the Barthel Index (Mahoney & Barthel, 1965), the Motricity Index (Collin & Wade, 1990), the Fugl-Meyer Assessment Test for the upper extremity (Fugl-Meyer, Jaasko, Leyman, Olsson, & Steglind, 1975) and the CAHAI (Chedoke Arm and Hand Activity Inventory) (Barreca et al., 2004).

Results

The RGS allows us to record hand position, arm joint angles, finger flexure and event related game data (spheres hit, grasped and placed). Moreover, with the evaluation phase (see Methods) we can analyze the movements of paretic and non-paretic arms in real and virtual worlds.

In a pilot study with stroke patients we observed that our system clearly allows measuring the asymmetries between paretic and non-paretic arms, and that these were preserved in the virtual environment (Figure 2) (Cameirao, Bermudez i Badia, Zimmerli et al., 2007). This means that the RGS can be used for monitoring the evolution of a patient across sessions, that the properties of the movements are transferred from real to virtual worlds, and that the training in both worlds is similar.

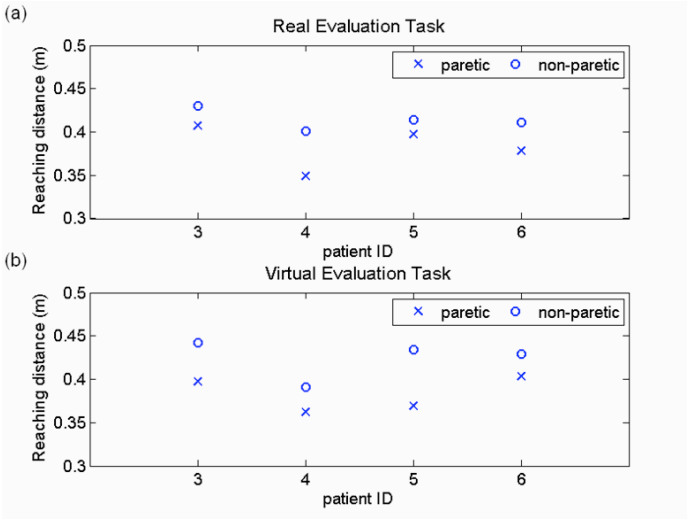

Figure 2. Maximum reaching distance of paretic and non-paretic arms across four stroke patients in the real (a) and virtual (b) evaluation tasks. The mean difference of the reaching distance between paretic and non-paretic arms was not significantly different (p=0.318) (Adapted from (Cameirao, Bermudez i Badia, Zimmerli et al., 2007)).

Concerning the current randomized clinical study, to date 2 patients (1 RGS and 1 Control A) completed the 6 month protocol (3 months training + 3 months follow-up), 5 patients (2 RGS, 1 Control A and 2 Control B) completed the 3 months therapy, 3 patients (2 RGS and 1 Control B) reached the 5 weeks of therapy stage, and 4 patients (2 RGS and 2 Control A) are in the first weeks of therapy. To summarize, to date a total of 14 patients are involved in this study.

Here we show the data of the 2 patients that completed the entire protocol. The scores of four clinical scales, namely the Functional Independence Measure, the Motricity Index, the Fugl-Meyer Assessment Test for upper extremities and the Chedoke Arm and Hand Activity Inventory (CAHAI) were used to perform an analysis of the percentage of improvement over time (Figure 3). The patient in the RGS group had the following scores at admittance: motor FIM = 24, Motricity Index = 29, Fugl-Meyer = 23 and CAHAI = 14. The patient in the Control A group had the follow-

ing scores at admittance: motor FIM = 31, Motricity Index = 34, Fugl-Meyer = 24 and CAHAI = 13. When we look at the improvement over time obtained for the motor part of the FIM we can see that both patients showed the same type of pattern (Figure 3a). On the other hand, on what concerns specific properties of the movements, evaluated by the Motricity Index and the Fugl-Meyer Assessment Test, the patient in the RGS group obtained better results in the Motricity Index at every time step (Figure 3b). On the Fugl-Meyer, the patient in Control A group presented a higher improvement at week 5, but then stabilized over the entire study period; the patient in the RGS group presented a sustained increase from week 5 until follow-up at week 24 (Figure 3c). Finally, the patient in the Control A group presented higher improvements in the Chedoke Arm and Hand Activity Inventory at the end of the protocol (Figure 3d). Although the data on two patients 1 on each group) is not enough to draw any conclusion, it helps us understanding that the analysis of the progress of the patients is ambiguous depending on what clinical scale we are considering. For instance, in the Motricity Index the patient in the RGS group had better results than the patient in the Control A group. However, this trend was opposite in the CAHAI. In these cases, the data obtained by the RGS (speed, range of movement and precision) can provide information that helps to solve ambiguity.

For the rest of the patients that are currently involved in the study but did not yet reach the follow-up stage, the data suggests that this VR therapy in the acute phase of stroke may have a measurable impact approximately from the second month on. Our data indicates that the RGS may induce a sustained improvement over the whole training period, whereas the control groups tend to stabilize at the second phase of the treatment.

Conclusions

Here we presented the Rehabilitation Gaming System (RGS), its design and the results of pilot studies and an ongoing clinical study. The RGS is a tool for the rehabilitation of motor deficits that has a number of properties that make it suitable for an appropriate rehabilitative training. First, it is built taking into account what is known about the mechanisms of recovery and correspondent efficient rehabilitation strategies. Second, it is VR based, allowing creating specific scenarios directed towards the disability in question. Third, the tasks follow a model that deploys an individualized training, adjusted to the capabilities of the user. Fourth, the tasks have increasing complexity and are presented to the patients at specific time periods in accordance with rehabilitation standards. And fifth, it allows continuous monitor-

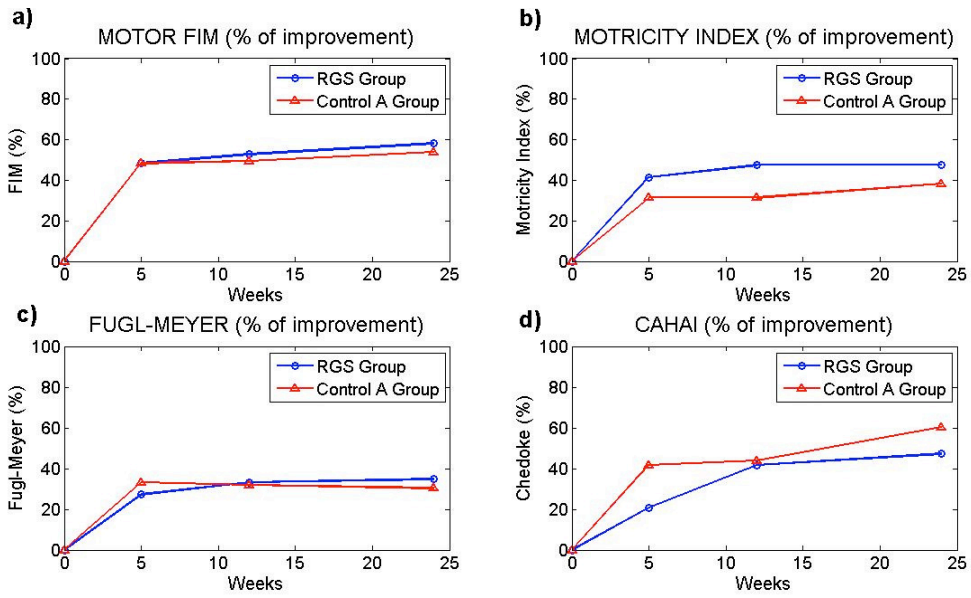

Figure 3. Percentage of improvement in standard evaluation scales obtained at different stages - week 0 (admittance), week 5, week 12 (end of treatment) and week 24 (follow-up) - for two patients. a) Motor part of the Functional Independence Measure. b) Motricity Index for the upper extremity. c) Fugl-Meyer Assessment Test for the upper extremity. d) Chedoke Arm and Hand Activity Inventory.

ing of the patient to evaluate its progress over time during the rehabilitation program. Moreover, the same task performed in real and virtual worlds showed that performance and movement properties are transferred from real to virtual worlds, indicating the equivalence of training in the virtual world (Cameirao, Bermudez i Badia, Zimmerli et al., 2007).

The RGS is currently being used in a randomized clinical study with two control conditions. Although at this moment the sample size is too small to draw any conclusion, we expect our system to have an impact on functional motor recovery, as well as in the management of daily living. In the following months we intend to assess the impact of this technique in a larger number of patients using not only the clinical evaluation scales at different stages of the treatment but also the quantitative data delivered the RGS.

Acknowledgments

This research is supported by the European project Presenccia (IST-2006-27731).

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Pain control during wound care for combat-related burn injuries using custom articulated arm mounted virtual reality goggles

Christopher Maani, MD†, Hunter G. Hoffman, Ph.D, Peter A. DeSocio, DO†, Michelle Morrow†, Chaya Galin†, Jeff Magula*, Alan Maiers† and Kathryn Gaylord†*

†U.S. Army Institute of Surgical Research, Brooke Army Medical Center, Fort Sam Houston, TX.
**Human Interface Technology Laboratory and Department of Mechanical Engineering, University of Washington, WA., www.vrpain.com, hunter@hitL.washington.edu*

We describe the first two cases where virtual reality was added to usual pain medications to reduce excessive pain during wound care of combat-related burn injuries. Patient 1, a 22 year old male, suffered 3rd degree burns on 32% of his body, including his right hand, during a roadside bomb terrorist attack in Iraq. The nurse administered wound care to half of the right hand during VR and the other half of the same hand during no VR (treatment order randomized). This patient was the first to use a unique custom articulated arm mounted VR goggle system. Three 0-10 graphic rating scale pain scores for each of the two treatment conditions served as the primary dependent variables. The patient reported less pain when distracted with VR (e.g., "time spent thinking about pain" dropped from 100% during no VR to 15% during VR, “pain unpleasantness” ratings dropped from “moderate” (6/10) to “mild” (4/10). Wound care was "no fun at all" (0/10) during no VR but was "pretty fun" (8/10) during VR. However, Patient 1 reported no reduction in worst pain during VR. Patient 2 suffered 2nd and 3rd degree burns when his humvee was hit by a terrorist's rocket propelled grenade in Iraq. During his wound care debridement, "time spent thinking about pain" was 100% (all of the time) with no VR and 0 (none of the time) during VR, "pain unpleasantness" ratings dropped from "severe" (7/10) to "none". Worst pain dropped from "severe" (8/10) to mild pain (2/10). And fun increased from zero with no VR to 10 (extremely fun) during VR. Although preliminary, using a within-subjects experimental design, the present study provided evidence that immersive VR can be an effective adjunctive nonpharmacologic analgesic for reducing cognitive pain, emotional pain and the sensory component of pain of soldiers experiencing severe procedural pain during wound care of a combat-related burn injury.

Key words, analgesia, burn pain, wound care, distraction, virtual reality

Introduction

U.S. soldiers injured in Iraq with significant burns are treated at the U.S. Army Institute of Surgical Research (USAISR) in San Antonio, TX. The mean length of inpatient stay for burn patients at BAMC ISR is approx 25 days.[1] Recovery often involves extensive outpatient physical therapy rehabilitation. Soldiers often move to San Antonio to continue their outpatient physical therapy for six months, a year or longer. Currently, wounded warfighters with severe burn wounds may have their bandages removed each day, so the wound can be inspected, cleaned and kept free of infection. Wounded warriors with severe burns remain conscious during daily wound care. Typically, they receive strong short-acting opioid analgesics and anxiolytics about twenty minutes prior to debridement (cleaning of dead skin from their healing burn wound). Despite early, aggressive use of opioid analgesics, patients frequently experience severe to excruciating pain during daily burn wound care.[2] Excessive pain can increase the amount of time it takes caregivers to complete the wound care, and can increase how long the patient remains in the hospital before discharge. Clinical and laboratory studies of civilians have shown large drops in subjective pain during virtual reality,[3,4] and fMRI results with healthy volunteers show reductions in pain-related brain activity during VR analgesia.[5] If VR reduces procedural pain in patients with combat-related injuries, this would be a valuable advance in combat casualty care with potential widespread military applications in the future. The two patients in this case report are the first to quantify whether VR distraction can reduce high levels of subjective pain reports in soldiers with combat-related burn injuries undergoing wound care and dressing change. Both patients used a unique articulated robotic-like arm that allowed the VR goggles to be placed near the patient

was harvested from unburned portions of his body and transplanted as skin grafts to many of his severe burn wounds. In keeping with the standard practice, continuous wound care and frequent dressing changes were required to optimize the healing process.

A 10 minute segment of wound care to the patient's right hand, identified from previous days' procedures as being excessively painful, was divided into two equivalent five minute wound care segments. Pre-medication with two percocet tablets by mouth approximately 20 minutes prior to wound care served as the opioid analgesic for this session. During one of the five minute sessions he received no VR distraction (i.e., standard pre-medication only). During the other five minute treatment session the participant looked into the articulated arm mounted VR goggles and underwent wound care while experiencing immersive, interactive VR (randomized to receive VR first or second).

During two brief pauses in the wound care procedure (once after each five minute intervention period), the patient completed three subjective pain ratings using Graphic Rating Scales (GRS) labeled 0 – 10 with respect to the preceding 5 minutes of wound care. Such pain rating scales have been shown to be valid through their strong associations with other measures of pain intensity, as well as through their ability to detect treatment effects. The specific measures used in the current study were designed to assess the cognitive component of pain (amount of time spent thinking about pain), the affective component of pain (unpleasantness), and the sensory component of pain (worst pain). Affective and sensory pain are two separately measurable and sometimes differentially influenced components of the pain experience.[5] Gracely et al,[6] have shown ratio scale measures such as the labeled Graphic Rating Scales used in this study to be highly reliable. In addition, a GRS rating of 'fun' during wound care was measured.[3]

Patient 2, a 21 year old male, suffered 2nd and 3rd degree burns when his humvee was hit by a terrorist's rocket propelled grenade in Iraq. The explosion caused 2nd and 3rd degree burns on 15% of his body: lower back, flank, buttox, bilateral hands, bilateral upper arms. A 12 minute segment of wound care to the patient's left and right arms identified from previous days' procedures as being excessively painful was divided into two equivalent six minute wound care segments. Pre-medication with one fentanyl lollypop (400 mic) and two percocet tablets by mouth approximately 20 minutes prior to wound care served as the opioid analgesic for this session. During one of the six minute sessions he received no VR distraction (i.e., standard pre-medication only). During the other six minute treatment session the participant looked into the articulated arm mounted VR goggles and underwent wound care while experiencing immersive, interactive VR (randomized to receive VR first or second). During two brief pauses in the wound care procedure (once after each six minute intervention period), the patient completed three subjective pain ratings using Graphic Rating Scales (GRS) labeled 0 – 10 with respect to the preceding 6 minutes of wound care.

The VR system consisted of a Voodoo Envy laptop with NVIDIA GForce Go 7900 GTX (512 MB) video card; Intel Core 2 Duo (T7400) CPU @ 2.16 GHz, 2 GB RAM @ 994 MHz). While in High Tech VR, each subject followed a predetermined path, "gliding" through an icy 3-D virtual canyon (Figure 2). He 'looked' around the virtual environment and aimed via a mouse. He pushed a mouse trigger button to shoot virtual snowballs at virtual snowmen, igloos, and penguins (see www.vrpain.com). Each subject saw the sky when he looked up, a canyon wall when he looked to the left or right, a flowing river when he looked down, and heard sound effects (e.g., a splash when a snowball hit the river) mixed with background music by recording artist Paul Simon. Participants looked into a pair of Rockwell Collins SR-80 VR goggles (see www.imprintit.com) with a custom made neoprene blinder on top and sides which largely blocked his view of the real world. These VR goggles afforded approximately 80° diagonal field of view for each of the rectangular eyepieces with 100% overlap between the right and left eye images. The goggles were held in place near the patient's eyes by a custom made articulating arm mounting system.

Results

Patient 1 reported less pain when distracted with VR (e.g., "time spent thinking about pain" dropped from 100% during no VR to 15% during VR, "pain unpleasantness" ratings dropped from "moderate" (6/10) to "mild" (4/10). Wound care during VR was "pretty fun" (8/10) vs. "no fun at

all" (0/10) during no VR and the patient reeported having a "moderate sense of going inside the computer-generated world" (6/10). VR did not reduce Worst pain (0% drop) in Patient 1.

Patient 2 reported that during his wound care debridement, Time spent thinking about pain was 100% with no VR and 0 with VR, "pain unpleasantness" ratings dropped from "severe" (7/10) with no VR to "none" during VR. Worst pain dropped from "severe" (8/10) with no VR to mild pain (2/10) during VR. And fun increased from zero with no VR to 10 during VR. Patient 2 reported having "a strong sense of going inside the computer-generated world" (8/10). Both patients and their wound care nurses noted that they would prefer VR be available for subsequent dressing changes as they found it to be helpful as an adjunctive modality for pain control.

Discussion

The results of these two case studies demonstrate that immersive VR reduced the reported amount of time patients with a combat-related burn injury spent thinking about their pain and VR reduced pain unpleasantness. VR did not reduce patient one's worst pain rating during his burn wound care. But VR did reduce patient two's worst pain from severe (a rating of 8) to mild (a rating of 2). Although case studies are scientifically inconclusive and controlled studies are needed, these results provide the first available evidence that VR can reduce severe acute pain during medical procedures (wound care and dressing changes) in patients with combat-related burn injuries. Because excessive acute pain during medical procedures for combat-related injuries remains a widespread medical problem, and our preliminary results support the notion that VR might prove valuable for pain control in combat trauma patients, additional research on this modality with this patient population is warranted.

Acknowledgments:

This study was funded by U.S. Army Institute of Surgical Research, with help from the Gustavus and Louise Pfieffer Research Foundation, and the Scan Design Foundation by Inger and Jens Bruun. Thanks to CPT Charles D. Quick,

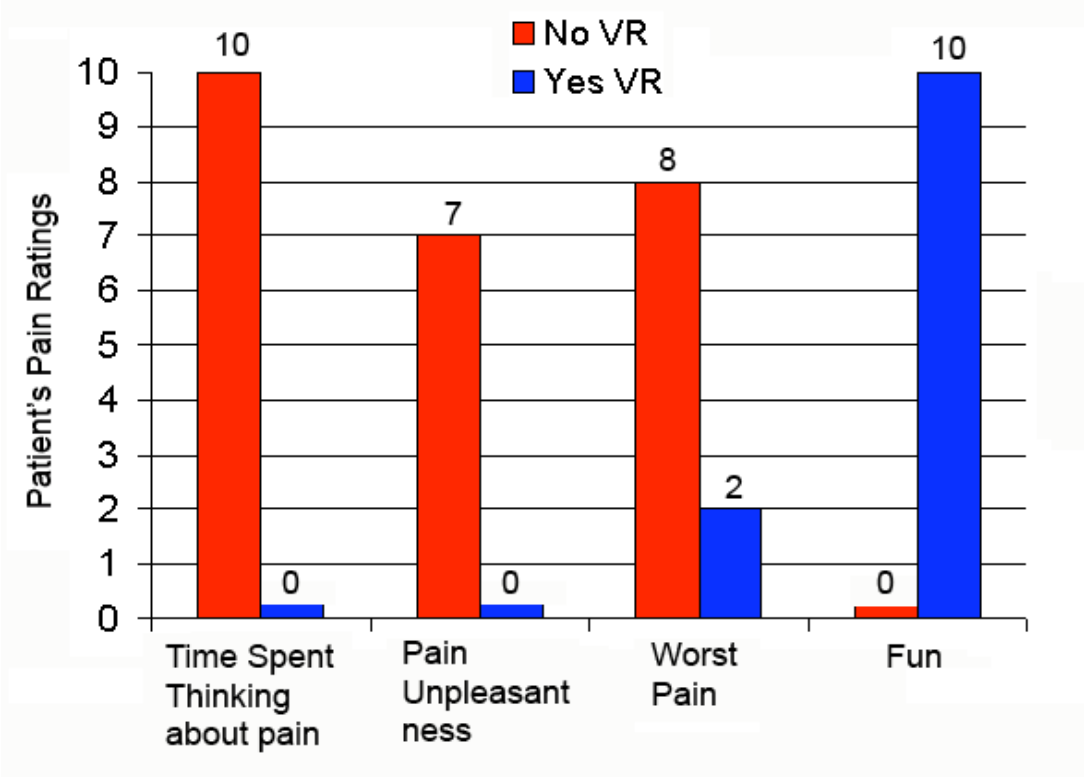

Figure 3. Patient 2 reported large reductions in pain during VR (shown in blue) compared to no VR (shown in red) during severe burn wound care of burn injury resulting from a rocket-propelled grenade attack/explosion.

(USAISR), Nancy Molter RN, MN, Ph.D. (USAISR) and SGT Darren Hall (USAISR) for their assistance implementing this technology in the Burn Center, and to COL Karl E Friedl, Ph.D., (Director of TATRC) Jean-Louis Belard, MD, Ph.D., (TATRC), singer/songwriter Paul Simon (New York), and Senator Kay Bailey Hutchison (Texas) for their encouragement.

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The ETIOBE Project: A Supporting System for Children Obesity

Rosa M.Baños.[1], Cristina Botella.[2], Álvaro Frías[3], Mariano Alcañiz[4], Ausias Cebolla[5], Ernestina Etchemendy[6], Soledad Quero[2], Sabrina Andreu[2]

[1]Universidad de Valencia
[2] Universitat Jaume I
[3]Hospital la Fe de Valencia
[4]Universidad Politécnica de Valencia
[5]CIBER Fisiopatología Obesidad y Nutrició n(CB06/03) Instituto Carlos III
[6]CIBER Fisiopatología Obesidad y Nutrición (CB06/03) Instituto Carlos III

banos@uv.es
botella@psb.uji.es
alvarofrias66@hotmail.com
malcaniz@degi.upv.es
au7s@yahoo.es
ernestinaetchemendy@yahoo.es
squero@psb.uji.es
andreum@psb.uji.es

The aim of ETIOBE project is to develop a cognitive-behavioural program for the treatment of obesity in children supported by new technologies (Internet, virtual reality) in order to potentate the efficacy and efficiency of the treatment program. Specifically, the system pretends to improve the treatment adherence by strengthening the auto-control mechanisms in the patients, in order to achieve the maintenance of therapeutic gains (change in eating habits and physical activity) and to prevent relapses by restoring healthy life habits.

ETIOBE consists of a tele-therapy system that includes three main applications:

1) *Clinician Supporting Application*. This application facilitates the therapists to personalize the acting-intervention protocol, according to the specific characteristics to each patient.
2) 2) *Home Supporting Application*. This application permits the communication between the child and parents with the therapist from home. With this system the child will also have access to the therapeutic contents stated by the therapist and to do some of the therapy assignments.
3) 3) *Mobile Supporting Application*. This application permits the child, by using mobile devices, to self-register in the context and real time and to access from the therapeutic advices and instructions using a “virtual agent”. In the present work a detailed description of the system is presented.

The Butler Project: Elderly people's satisfaction with new technologies

Cristina Botella[1], Diana Castilla[1], Rosa M.Baños[2], Juana M. Bretón-López[1], Mariano Alcañiz[3], Azucena García-Palacios[1], José Antonio Lozano[3], Berenice Serrano[1]

[1]Universidad Jaume I
[2]Universidad de Valencia
[3]Universidad Politécnica de Valencia

botella@psb.uji.es
castilla@sg.uji.es
banos@uv.es
Breton@psb.uji.es
malcaniz@degi.upv.es
azucena@psb.uji.es
jlozano@dsic.upv.es
bserrano@psb.uji.es

The Butler Project consists of a cognitive and emotional tele-assistance system for the elderly. Specifically, this system creates the ability to carry out early diagnosis, intervention, and follow-up of the physical, cognitive, and emotional state of elderly people, and in this way to improve their quality of life and to prevent their social isolation. Moreover, the Butler system offers several professional advantages; for the psychologist, this system offers an early detection of emotional state, diagnosis, easy assessment and therapy tool. For the geriatric hospitals, this system can be used like an occupational therapy tool. Through this, the professional (psychologist and geriatric hospital) can be warned through the Butler Project when it detects a severe emotional state. From the technological point of view, the Butler system offers the elderly several tools based in telecommunication (e-mail, chat, and videoconference adapted to the users' needs) and Virtual Reality techniques. One of the telecommunication tools addressed to prevent social isolation that characterises this population is the Book of life. The Book of life is used in order to create an individual memory space composed by several audiovisual stimuli related to their own life and share it with other users (e-g., videos, music, images or sentences). For instance, a user can share a photograph or a video associated to a piece of music of his/her family/friends with other users. The aim of this work is to present the results obtained in a case study about the satisfaction of real user with the book of life.

Is presence in a physical environment influenced by arousal and attention? A study conducted on researchers in cyberpsychology.

Stéphane Bouchard, Geneviève Robillard and Stéphanie Dumoulin
Université du Québec en Outaouais

Stephane.bouchard@uqo.ca

Almost all researchers on presence agree with the simple definition of presence, which is the feeling of being *there* in the virtual environment. However, this is where the consensus stops. There is no general agreement on the nature of presence, what constitutes an acceptable operational definition, which factors play a key role to create a strong illusion of non-mediation or how to best suspend disbelief.

Despite this lack of agreement, researchers continue to conduct experimental research on presence. Given the increased interest on the relationship between presence and anxiety, it is essential to differentiated presence, arousal and attention. Do researchers in the field confound the impression of being somewhere in the virtual environment with arousal or increased attention? In the physical reality, a person attending a conference should be able to recognize where he or she is (i.e., in the conference room) and that should not be influenced by emotional arousal. When aroused, a person could feel more emotions or an increase in attention towards specific stimuli, he or she but should not be more "here" in the room than he or she already is. The aim of the current study is to test if researchers in the field of cyberpsychology rate their feeling of being present in the physical environment differently following changes in arousal and attention.

The present study was conducted live during the conference, without the conference attendees' awareness. At the beginning of the symposium on presence, one of the co-chair of the symposium (Stéphane Bouchard) invited attendees to participate in a study on presence. Participants received three sheets of paper: (a) a blue one for collecting descriptive data, their awareness of the upcoming manipulation and the baseline level of presence, (b) a green one for recording the current level of presence after the third talk, and (c) a yellow one for recording the Post experiment level of presence during the experimenter's oral talk. The level of presence was measured using the following single-item scale (in percentage): "To what extent did you feel present in this conference room in the last 20 seconds?". In order to set the scene for the experimental manipulation, the experimenter received three phone calls on his cell phone during the conference, just prior to various oral talks. The experimental manipulation of arousal and attention occurred during the experimenter's talk and was as follow: 90 seconds after starting to give his oral talk, the experimenter received a phone call, picked-up and promptly said "I'm in the middle of a conference! I can't talk to you right now! Just tell your lawyer that I don't care about the house, all I want is joint custody of the kids!". Then the experimenter asked attendees to record the Post experiment rating of presence and give their answers to research assistants who entered the data and completed the analyses while the experimenter completed his talk. Results were included in the final minutes of the experimenter's talk and are available on the conference web site at www.interactivemediainstitute.com/index_conf.html, under the 2008 conference, Powerpoint presentations, Presence symposium. Results were discussed in the light of researcher's ability to differentiate between presence and arousal or attention.

Cognitive Display

Yang Cai

Carnegie Mellon University

Despite the rapid development of cyber technologies, today we still have very limited attention and communication bandwidth to process the increasing information flow. The goal of the Cognitive Display is to develop a context-aware filter to match the information load with particular needs and capacities. The functions include: bandwidth-resolution, trade-off, and user context modeling. From the empirical lab studies, it is found that the resolution of images can be reduced in orders of magnitude if the viewer knows what is looking for particular features. The adaptive display queue is optimized with real-time operational conditions and user's inquiry history. Instead of measuring the operator's behavior directly, ubiquitous computing models are developed to anticipate the user's behavior deriving from the operational environment data. A case study of the video stream monitoring for transit security is discussed in this paper. In addition, the presentation addresses the future direction of coherent human-machine vision systems.

Virtual Reality for the ecological training of planning and memory abilities in elderly population

Laura Carelli [1 2], Francesca Morganti [1 2] , Giuseppe Riva [1 3]

[1] Applied Technology for Neuro-Psychology Lab, Istituto Auxologico Italiano, Milano, Italy
[2] Department of Human Sciences, University of Bergamo, Italy
[3] Department of Psychology, Catholic University of Milan, Italy

l.carelli@auxologico.it

The use of virtual reality (VR) in clinical psychology has become more widespread. The key characteristics of virtual environments for most clinical applications are the high levels of control of the interaction with the tool, and the enriched experience provided to the patient.

Cognitive and rehabilitation psychology are two branches of psychological sciences in which VR stands to have significant impact.

Specifically, VR offers the potential to deliver systematic human testing, training, and treatment situations, that are fully functioning, dynamic and actual prototypes of relevant activities, within which sophisticated behavioral recording is possible.

A large amount of literature has investigated the effect of aging on high-order cognitive functions (named "executive functions"). Specifically, some components of executive functioning observed to decline with aging are working memory, efficiency of task switching and planning actions in a complex environment. Many studies have also found that cognitive stimulation can improve general performance and prevent these difficulties. Particularly, the involvement in activities no longer as simply observers, but active participants can support their commitment and a generalized learning.

In this regard, much like a surgical simulator serves to test and train surgical skills, virtual environments can be developed to present ecological simulations that may be used in the assessment and training of planning and memory abilities.
Previous studies have investigated aging effects on planning and memory abilities, mainly using laboratory-based neuropsychological tasks such as the Tower of London. In this study we used the free virtual reality toolkit NeuroVR (http://www.neurovr.org) to develop the setting for more naturalistic tasks, such as organizing shopping errands. In the study, the subject enters the front door of a Virtual Supermarket for a virtual shopping trip. The user has a predefined shopping list that he/she can take to the store with him/her.

One group of participants (20 elderly subjects aged from 50 to 65) experienced the virtual supermarket task. In the first part of the virtual shopping trip, participants were required to find and collect the items included in the shopping list. In the second half of the trial, they were signaled by an auditory message to execute an intentional and voluntarily switch from their current task.

The results of this "in progress" study will be discussed in the context of using realistic virtual assessment for future functional planning and memory assessment/ training applications with elderly persons having cognitive decline.

"Reality tests" increase the efficacy of *in virtuo* exposure for claustrophobics

Stéphanie Dumoulin, Ph.D. cand., Stéphane Bouchard, Ph.D., Geneviève Robillard, M.A. & Julie-Eve Arsenault, M.A

Cyberpsychology Lab of the University of Quebec in Outaouais (Gatineau, Québec, Canada)

tifdum@hotmail.com

Conducting exposure in virtual reality (*in virtuo* exposure) is a promising and effective approach for the treatment of anxiety disorders. But since the user immersed *in virtuo* is not exposed to a physical phobogenic stimulus, one can wonder if it would be beneficial for the patient to "test" his improvements in the physical reality. Some studies conducted with imagination exposure (Gauthier & Marshall, 1977) showed a consolidation effect when the patient can confirm his or her treatment gain. It is important to note however, that these "reality rests" do not represent additional *in vivo* exposure exercises. In the Gauthier and Marshall study, the patient was told only "to see what they can do now". This is significantly different from confronting their feared stimuli or to wait for a significant amount of time until the anxiety decreases. The impact of the consolidation experience can be best explained in the context of self-efficacy. Performing the feared behaviour, even for a brief moment, allows the patient to see that he or she can actually do it (Bandura, 1996).

The goal of this study is to assess whether the addition of a brief "reality check" can improve the efficacy of *in virtuo* exposure. Our hypothesis is that a consolidation experience would increase the impact of the treatment.

The sample consists of 18 participants aged between 24 and 66 year old, diagnosed with claustrophobia according to the *Structured Clinical Interview for DSM-IV*. Participants were randomly assigned to two conditions: (a) Virtual Reality only (VR; traditional VR exposure treatment), or (b) Virtual Reality plus consolidation (VR+). In the VR+ condition, participants received the same treatment as in the VR condition, except that the last 10 minutes of each session were devoted to the consolidation. For the consolidation, participants were told "You have the chance to test for real how much progress you made in therapy today. You can enter the closet, close or lock the door and stay in there if you want. You do not have to do it and you can stop whenever you want. You do not have to push yourself, as you would do during exposure or the pre/post therapy assessment. This is just an opportunity to see how good you are now."

During each of the seven weekly 90-minute therapy sessions, participants were immersed in one of the two VR environments sold by Previ™ for claustrophobia (i.e. virtual elevator or magic room). The treatment outcome was measured with two main variables: the claustrophobia questionnaire and a behavior avoidance test. The behavior avoidance test consisted of getting inside a dark 22 by 31 inches closet, locking the door and staying there alone for up to five minutes. Other questionnaires were also administered, such as the Claustrophobic Scale, the Fear Questionnaire, the Fear Survey Schedule-II, the State-Trait Anxiety Inventory, the Beck Depression Inventory, the Presence Questionnaire, the Simulator Sickness Questionnaire and brief ratings using a 100% Subjective Units of Discomfort Scale were during the immersion.

Repeated measures ANOVAs were used to compare the two conditions pre and post therapy. The analyses confirmed our hypothesis, with a significant Condition X Time interaction between the VR group and the VR+ group on the Claustrophobia Questionnaire [$F = 5.124$, $p < .05$] and the behaviour avoidance test [$F = 44.138$, $p < .001$].

Low Cost Webcam and Off The Shelf Game Interfaces to Produce VR Systems for Motor Rehabilitation After Traumatic Brain Injury, Spinal Cord Injury and Amputation

Sheryl Flynn[1], Ph.D, Belinda Lange[1], Ph.D, Shih-Ching Yeh[2], Ph.D candidate, & Albert 'Skip' Rizzo[1], Ph.D.

[1]Institute for Creative Technologies, University of Southern California,
[2]Integrated Media Systems Center, University of Southern California, Los Angeles, CA

Current research indicates that TBI-related loss of motor function can be recovered or improved via a repetitive task-oriented motor training regimen that practices activities targeting specific relevant movement, and is intensified in a hierarchical fashion based on patient progress. Early research suggests that Virtual Reality game-based technology can be used to improve motor skill rehabilitation of functional deficits including reaching, hand function and walking. However, clinic and home-based systems need to be affordable and easy to deploy and maintain, while still providing the interactional fidelity required to produce the meaningful motor rehabilitation activity needed to foster transfer to the real world. High-end laboratory-based systems do not meet cost and deployability requirements. This paper will discuss the initial set up and preliminary findings of a Virtual Reality and game-based motor rehabilitation area within a Physical Therapy Clinic for patients with Spinal Cord Injury (SCI), Traumatic Brain Injury (TBI) and Amputation. The VR systems chosen for this research were the Sony PlayStation® 2 EyeToyTM, Nintendo® WiijTM, and Novint® FalconTM and a Light tracking system developed at the Institute for Creative Technologies. The main purpose of this research was to 1) define the game/model characteristics that are enjoyed most by the players; 2) develop new games, or manipulate the current games to address these user-defined characteristics; 3) develop and start a training protocol that will improve strength, sensation, balance, cognition, reaction time, endurance, and/or function. This presentation will discuss the findings from the first phase of the study. This first phase, currently in progress, is a focus study consisting of 15 participants with SCI (n = 5), TBI (n = 5) and amputation (n = 5). Participants are provided with demonstrations of the light tracking system and standard games from the Sony PlayStation® 2 EyeToyTM, Nintendo® WiiTM, and Novint® FalconTM. Participants are then asked to complete a questionnaire regarding their perception on the each system's usability, appeal and enjoyment. The participants are then able to use each of the systems for approximately five minutes at a time to avoid fatigue. A final questionnaire is then completed by participants regarding their perception of each of the systems and they are then given the opportunity to provide ideas or comment about what they would like from each of the systems or games. The findings from this focus group will be discussed in terms of what each group of participants (SCI, TBI and amputee) liked and disliked about each of the systems following observation of the investigators using the systems and then following their own experience with each of the systems. The future directions of the research will also be discussed. It is anticipated that this study will develop Virtual Reality game-based tools that can be used for motor rehabilitation training within clinics or as part of a home-based exercise regime.

New assessment for old addictions
The use of Virtual Reality in the alcoholism

Elena Gatti Ph.D. Candidate[1],Riccardo C. Gatti, PhD[2], Tiziana Lops M.S.[2], Rosanna Massari M.S.[2], Cinzia Sacchelli M.S.[2], Giuseppe Riva Ph.D.[1,3],

[1]Department of Psychology, Catholic University of Milan, Italy
[2]National Service Care, ASL Città di Milano, Milan, Italy
[3]Applied Technology for Neuro-Psychology Lab, Istituto Auxologico Italiano,Milan, Italy

elena.gatti@unicatt.it

The assessment with alcoholism-dependent subjects involves the use of a traditional case history. Semi-structured interviews are the main approach used to explore the circumstances that have led to the first appointment being made and exploring the alcoholic's history. But, this procedure could be considered threatening for the patients because they may be coming with the expectation that if they admit the reality of their behaviour they are putting themselves at risk. He or she is exposing themselves to a reaction of people they do not know, and they may be afraid of being demeaned by stranger (Edwards, Marshall & Cook, 2006). The case history obtained will then be filtered through these defenses and may be inaccurate. These risks are dangerous for the assessment of the individual and for his/her therapy program; the use of Virtual Reality (VR) could be a way to reduce these risks. The aim of this study is to explore the use of VR and its empowerment in a case-history setting. The sample is composed by 40 alcohol dependent patients (20 experimental group and 20 control group) asking for treatment to the Italian National Service Care. We administered to experimental group two self report questionnaire (Self efficacy scale and MAC 2-A) at start and at the end of assessment; and a VR protocol based on four different virtual environments (park, apartment, workplace and restaurant). The control group completed only two questionnaires at first and last appointment. All the patients edited the Eysenk Personality Inventory as well.

In actuality, the study is in progress, but the preliminary results show that the sense of self-efficacy and the motivation for change increase in the final session, only in experimental group. The patients enrolled in the VR protocol were more available to start a therapy and they are more oriented to "Action" than control group. Furthermore, experimental group was more satisfied and pleasure of new assessment form.

These preliminary results indicate that VR could be a new instrument to assess alcohol dependent patients, because the procedure is easy to administer and gives a lot of information about many aspects of patients' past and present life, relationships, family history, attitudes, intentions and drinking habits.

SECTER: Simulated Environment for Counseling, Training, Evaluation and Rehabilitation

Daniel Gillette, Ed.M. and Walter Greenleaf, Ph.D.

Greenleaf Medical, 261 Hamilton Ave., Suite 409, Palo Alto, CA 94301

When conducting office-based therapy, clinicians often face the challenges of client comfort level and resistance; cognitive impairment (both transient and chronic); and difficulty transcending the physical environment and client/clinician roles. These issues are often most significant when conducting imaginal or role play therapy, or practicing resistance and social skills. In such instances, there is not only a need to process past and possible future events that the client may find uncomfortable, but also a heavy load placed on the memory and imagination of all involved. For instance, when conducting a role play session to practice skills for dealing with difficult social settings, the client and therapist must imagine a specific setting, act out their roles, stick to the plot, and keep a running record of the activity for later review and analysis. Such an activity requires powerful cognitive skills that many do not possess. Multi-user virtual environments (MUVEs) have the potential to remediate many of these issues, as well as lay a foundation for the development of new interventions.

For the past two years, in conjunction with our partners at CFG Health Systems, we have been developing and testing SECTER (Simulated Environment for Counseling, Training, Evaluation, and Rehabilitation), built on the OLIVE platform from Forterra Systems. In SECTER, therapists and clients can meet one-on-one and in groups. The settings and objects are malleable, allowing for changes in venue and environmental conventions. Interaction occurs naturally through speech communication facilitated by voice over IP (VOIP) that is integrated into the auto-gestures of avatars, meaning that when one talks, his/her avatar's mouth moves accordingly. SECTER not only has tools for rich real-time interaction, but also for dynamic after action review (AAR) -- therapists and clients can review a session on-screen and control the viewing perspective in real-time. Additionally, there is the capability to perform in-ear coaching, where the therapist can invisibly observe real-time action and provide discrete coaching directly to the ear-set of any of the other users. Such coaching has been used not only in group therapy sessions but to train mental health professionals. Currently, SECTER is installed on three residential adolescent treatment wards, and at the McGuire Air Force Base, being used to treat oppositional defiant disorder (ODD); trauma spectrum disorders; drug and alcohol abuse; anger management; attachment issues; self-esteem issues; developmental disabilities; and a variety of other disorders. Early data is encouraging, with clinicians easily applying their existing skills in the virtual world, clients reporting high satisfaction, and evidence of improved achievement of many therapeutic goals. In this paper, we will discuss some of the lessons learned in the past two years of SECTER research and development; the types of interactions clinicians have enacted in the virtual world; how SECTER use has expanded the therapeutic process; and what is planned for future development.

Projet de résumé pour le CT_{13}
A Virtual Arm to Stop Smoking. A comparative study.

Benoît Girard [1], Md, MSc, FRCPc, Vincent Turcotte[1], 3D Tech & Stéphane Bouchard[2]. Ph.D.

[1]GRAP, Clinic of occupational psychology, Jonquière, Canada
[2]Université du Québec in Outaouais, Gatineau, Canada

g.r.a.p@videotron.ca
stephane.bouchard@uqo.ca

We reported in a pilot study presented at last year's Cybertherapy Conference (Girard & Turcotte, 2007) that using an action-cue exposure strategy in virtual reality (ACE-VR; crushing virtual cigarettes) might be useful in the treatment of tobacco addiction.

We are pursuing research in this area with a randomized control trial based on 90 smokers who will receive a brief psychosocial smoking cessation program (25 people are enrolled so far and we expect to finish the study before the conference). During the first four weeks of an eight-session psychoeducational and motivational program, all participants will be immersed in VR. During the immersions in VR, 45 of the participants will use a virtual arm to catch and crush virtual cigarettes. The other half of the sample will use the virtual arm to catch virtual fruits (control condition).

The smoking frequency, and abstinence, will be assessed with a daily diary and exhaled carbon monoxide tests (the CO_2 tests will provide an objective confirmation of the abstinence reported in the diaries). The success the program will be based on the number of subjects who quitted or reduced their smoking frequency. The severity of addiction will be assessed with two questionnaires, the Fagerstrom and the Horn tests. Craving and withdrawal effects will be measured with the Minnesota Nicotine Withdrawal Scale (MNWS) and the Brief Questionnaire of Smoking Urges (QSU-Brief) at the baseline and at the visits from weeks 1 through 4, 6, 12 and at the end of the program. Before the VR immersion, the Immersive Tendencies Questionnaire will be administered and after each VR session participants will fill two questionnaires addressing presence and cybersickness. The comparative impact of both treatments will be tested with repeated measures ANOVAs (and planned contrasts) with sufficient power to detect medium effect sizes.
The main goal of our study is to show that crushing virtual cigarettes can boost the impact of a behavioral program dedicated to cigarette addiction. We will present at CT13 the results of data collected up to the first and third months follow up.

The potential of Virtual Reality as anxiety management tool: a randomised controlled study in a sample of patients affected by Generalized Anxiety Disorder

Alessandra Gorini[1], Ph.D. candidate & Giuseppe Riva[1,2], Ph.D

[1]Applied Technology for Neuro-Psychology (ATN-P) Lab., Istituto Auxologico Italiano, Milan, Italy
[2]Interactive Communication and Ergonomics of New Technologies (ICE NET) Lab., Università Cattolica del Sacro Cuore, Milan, Italy,

alessandra.gorini@gmail.com

Generalized anxiety disorder (GAD) is a psychiatric disorder characterized by a constant and unspecific anxiety that interferes with daily-life activities. Its high prevalence in the general population and the severe limitation it causes in patients affected by it, illustrates the necessity to find new and efficient strategies to treat it. Together with the cognitive-behavioural treatments, relaxation represents a useful approach for the treatment of GAD, but it has the limitation that it is hard to be learned by subjects. To overcome this limitation we propose to use virtual reality to facilitate the relaxation process by visually presenting key images to facilitate relaxation and acceptance. The visual presentation of a virtual calm scenario can facilitate the patients' practice and mastery of relaxation, making the experience more vivid and real than the one that most subjects can create using their own imagination and memory, and triggering a broad empowerment process within the experience induced by a high sense of presence.
According to these premises, the aim of the present study is to investigate the advantages of using a VR-based relaxation protocol in reducing anxiety in patients affected by GAD.

The trial is based on a randomized controlled study, including three groups of 15 patients each: (1) the VR group, (2) the non-VR group and (3) the waiting list (WL) group. Patients in the VR group will be taught to relax using a VR relaxing environment and audio-visual mobile narratives. Patients in the non-VR group will be taught to relax using the same relaxing narratives proposed to the VR group, but without the VR support and patients in the WL group will not receive any kind of relaxation training. Psychometric and psychophysiological outcomes will serve as quantitative dependent variables, while subjective reports of participants will be used as qualitative dependent variables.

We believe that the use of VR for relaxation represents a promising approach in the treatment of GAD since it enhances the quality of the relaxing experience through the elicitation of the sense of presence. This controlled trial will be able to evaluate the effects of the use of VR in relaxation while preserving the benefits of randomization to reduce bias. Its design takes into account the need for internal and external validity and that the results are attributable to the intervention.

Data analysis will start soon and the results will be ready in few months for inclusion in this manuscript and in the conference presentation

The influence of media content and media form in the induction of emotional experience. A preliminary study

Alessandra Grassi, Ph.D Candidate [1], Andrea Gaggioli, Ph.D [1-2], Daniela Villani, Ph.D [1], Giuseppe Riva, Ph.D. [1-2]

[1] Department of Psychology, Catholic University of Milan,
[2]Applied Technology for Neuro-Psychology Lab, Istituto Auxologico Italiano, Milan, Italy

alessandra.grassi@unicatt.it

The aim of this work is to check if the induction of emotional experience can be influenced through multimedia (audio/video) contents. Moreover, the authors want to evaluate the relationship between the media content and the media form during the emotions induction process.
The hypotheses are:

- different multimedia contents induce an emotional change in subjects;
- media form does not influence the emotions induction process;
- media form does not influence the sense of presence.

This study has a mixed design (3x6). The first independent variable refers to media form and is measured between subjects on three levels: mobile phone (MP), pc desktop (PD) and Head Mounted Display (HMD). The second independent variable refers to media content (6 video clips presented to the subject) and it is measured with repeated measures analysis. It is a within subjects analysis. The dependent variables are: emotional state induction and sense of presence.

The project sample includes 46 subjects, college students aged between 20-30 years old (23 females and 23 males). The sample has been randomized for "media" condition. Each participant watched 6 clips using three different media. Six video clips (Gross & Levenson, 1995) will be used in order to induce different emotional states. These emotional states are: amusement, fear, sadness, anger, surprise and neutral.

Each participant was administered the following questionnaire:

- before the experience:
  - EPI (*Eysenck Personality Inventory, 1975*);
  - Vas (*Visual Analogue Scale, Gross & Levenson, 1995*).
- after the experience:
  - Vas (*Visual Analogue Scale, Gross & Levenson, 1995*);
  - Panas Beta(*Positive Affect Negative Affect Scale, Watson e coll, 1988*);
  - Ucl-Sus (*Slater & coll, 1994*);
  - Post-film questionnaire (*Gross & Levenson, 1995*).

Biofeedback was also used for monitoring physiological changes before and after the multimedia experience.
At the moment the study is in progress. Final results will be presented at the 2008 Cybertherapy Conference.

Psychophysiological Aspects of Tobacco Use and Craving

Leigh W. Jerome, Ph.D.[1], Patricia J. Jordan, Ph.D. [2], Rebekah Rodericks, M.P.H.[2]

[1]Institute for Triple Helix Innovation ; [2]Pacific Telehealth & Technology Hui
Honolulu, HI

Leigh.Jerome@triplehelixinstitute.org

Studies of smokers in both laboratory and naturalistic environments have confirmed a positive relationship between exposure to smoking cues and measurable changes in subjective and physiological responses (e.g., Baumann & Sayette, 2006; Bordnick, Graap, Copp, Brooks, & Ferrer, 2005; Dols, Willems, van den Hout, & Bittoun, 2000; Harakeh, Engels, van Baaren, & Scholte, 2007). The craving to smoke seems to increase particularly in the presence of smoking-related cues (Carter & Tiffany 1999) and has led to cue exposure research aimed at stimulating craving in participants under a myriad of conditions. This study uses principles of cue exposure and non-invasive sensors to investigate the biometric signature associated with elicited arousal and tobacco craving. It is anticipated that comparisons of physiological responses to arousal and tobacco craving in different groups may enable researchers to differentiate arousal due to stress reactivity and craving. Although the study is not aimed at advancing the cue reactivity literature per se, there are several gaps in this field that the proposed study may be able to bridge. For example: Can physiological responses to cue exposure be used to predict behavior? How do physiological arousal/craving patterns differ between deprived smokers and non-deprived smokers in response to smoking cues? Does psychophysiological arousal differ between smokers and non-smokers? The study proposed herein builds on findings from a pilot study, conducted and presented at CyberTherapy in 2006 (Jordan, Jerome & Faraj, 2006). Pilot mediation analysis suggested psychological variables mediated the relationship between physiological indicators and smoking behavior (Baron & Kenny, 1986); findings that are consistent with previous research that has demonstrated strong physiologic connections between emotional expression and physiological arousal (e.g., skin conductance, temperature, respiration, blood flow) (Nasoz et al., 2004; Picard, 2001). Our follow-up study, currently underway, hypothesizes that biometric data can identify and predict arousal patterns associated with tobacco use behavior. It is further hypothesized that examining physiological and psychological patterns of cue reactivity can differentiate between psychological craving and physiological arousal in smokers. Participants in this semi-randomized four-group design include non-smokers (n=23); former smokers (n=23); current smokers (n=23); and deprived smokers (for 6-8 hours, n=23). In addition to a 3-day naturalistic baseline, individual experimental sessions are structured to include: a) an attenuation/calibration phase; b) a standardized elicited stress activity to collect baseline readings of arousal; and c) a cue exposure presentation consisting of 12 validated video clips to elicit various types of arousal (Rottenberg, Ray, & Gross, 2006). Participants rate their craving and arousal levels following the presentation of each film clip (Sloan, 2004). In addition to a more detailed discussion of the research methodology and statistical analysis plan, preliminary data will be presented. Standardized cue exposure challenges under controlled laboratory conditions, provide a powerful paradigm to examine the multidimensional aspects of arousal and craving and to test the full scope, and mediating and moderating mechanisms of the relationship between substance use cues and craving.

(#510)

The illusion of virtual body ownership during visual-motor movement

Wonho Lee[1], M.S. Candidate, Jeonghun Ku[1], Ph.D., Sangwoo Cho[1], Ph.D. Candidate, Hyeongrae Lee[1], Ph.D. Candidate, Kiwan Han[1], Ph.D. Candidate, Jinsick Park[1], Ph.D. Candidate, Jae-Jin Kim[2], M.D., Ph.D., In Young Kim[1], M.D., Ph.D., Sun I. Kim[1], Ph.D.

[1]Department of Biomedical Engineering, Hanyang University, Seoul, Korea
[2]Institute of Behavioral Science in Medicine, Yonsei University Severance Mental Health Hospital, Seoul, Korea

When I decide to write, I do not need to look for my hand in the same way that I have to look for a pen or a piece of paper, because my hand is ‘‘always there’’, present with me. The term ‘body ownership’ has been given to this experience. This sense of one’s own body as part of the self is a fundamental aspect of self-consciousness. The sense of body ownership presumably depends on afferent sensations arising within the body itself, but also on the coherence of current sensory input with pre-existing cognitive representations of the body. Psychological and neurological studies classically distinguish at least two internal representations of the body, often called body schema and body image. The link between these representations and the phenomenal sense of ownership has not been explored. In this study, we compared the strength of virtual hand illusion, like rubber hand illusion, induced by synchronously and asynchronously (scale factor controlled) movement, to investigate the contributions of visual-motor stimulation and ownership to body awareness. The system was implemented in 3D Game Studio A6 as windows-based application program to present Virtual Environment (VE) and a 3 degree of freedom tracker to measure the participants’ forearm angle. In the VE, participants moved the virtual hand toward randomized target angle with visual feedback. Participants saw the virtual image through the head mounted display (HMD). The experiment tasks consisted of a one synchronous condition and four asynchronous conditions. In the synchronous condition, the virtual hand angle corresponded to the real hand angle (real hand angle ´ 1), while the asynchronous conditions showed the virtual hand angle scaled by a scale factor of the real hand angle (real hand angle ´ 0.5, 0.7, 1.2, 1.5). Participants repeated each condition until they felt the virtual hand to be their real hand. If they had ownership to the virtual hand, then they moved the virtual hand toward target angle without visual feedback that repeated 5 times. At that time, the error of real hand angle to target angle was measured. Three kinds of measurement were obtained in this study. One is self-report to directly assess participants’ ownership experiences, another is the error of real hand angle, and the other is questionnaire of virtual hand ownership. Three healthy right-handed volunteers (average age: 24.3, range: 22~ 27, SD: 2.51), 3 male subjects, were recruited for this study. The results show that the number of average trials that occurred ownership was 9.1 trials in the synchronous condition and 12.3 trials in the asynchronous condition. The average scores from the ownership questionnaire, synchronous condition and asynchronous conditions were 18 and 13.6, respectively. The average error that real hand angle was at 4.3 degrees in synchronous condition and 15.8, 9.5, 8.6, 12.8 degrees in each asynchronous condition (real hand angle ´ 0.5, 0.7, 1.2, 1.5). According to the results, we conclude that the synchronous visual-motor movement causes the illusion of virtual body ownership more than asynchronous visual-motor movement. The illusion of virtual body ownership affect visual-motor program.

Adaptation of the virtual reality system EMMA to infancy

C. López-Soler[1], C. Botella, R. Baños[3], V. Fernández[4], M. Alcántara[4], M. Castro[4], S. Quero[2], D. Castilla[2] C. Montalvo[1]

[1]Universidad de Murcia
[2]Universidad Jaume I
[3]Universidad de Valencia
[4]Universidad de Murcia

clopezs@um.es
botella@psb.uji.es
banos@uv.es
VISI_FER@telefonica.net
mavi_alcantara@yahoo.com
maracastro@um.es
squero@psb.uji.es
castilla@sg.uji.es
carmengm@um.es

New Communication and Information Technologies (CITs) are being used in several health specialities. A new application has been developed in Health and Clinical Psychology, for the psychological treatment of different anxiety disorders and, being relevant in the therapy of post-traumatic stress disorder in adults (Botella et al, 2006). The virtual reality program named EMMA (Engaging Media for Mental Health Applications), allows us to work with the negative emotions related to the psychological problem. We present the first adaptation and application worldwide of EMMA's system in maltreated children with severe traumatic reactions.

The adaptation of EMMA to therapy with children consisted of the following modifications: introduction of symbols, specific images about social and family issues (e.g., photographs of male and female children faces showing different emotional expressions, diverse family groups, a father and/or mother with an aggressive attitude towards children, a child hidden under a table…), modelling of significant characters of heroes within the children's world (superman, supernenas, and Kim Posible). In the Database Screen, the redesign (retesturado) of the Book of Life and the Drain and modifications in the scenarios included elements in each of them that favour the perception of children's world (a hut in the meadows, an igloo in the snow-covered town, a tent and a sand castle in the beach and, a cave in the desert).

Besides, a tests presentation and data collection system addressed to facilitate the storage of each case has been introduced together with the recording of tales and other elements that make the application of EMMA easier for children. In this work, a detailed description of the modifications made in the EMMA system for an adequate use in infancy is presented.

Pulse!!© The Virtual Clinical Learning Lab: Preliminary Findings on Usability and Playability

Claudia L. McDonald[1], Ph.D., Jan Cannon-Bowers[2], Ph.D., & CMDR James R. Dunne[3], M.D.

[1]Texas A&M University-Corpus Christi
[2]University of Central Florida
[3]National Naval Medical Center Bethesda

Background

Pulse!! The Virtual Clinical Learning Lab is a federally-funded research project designed to develop state-of-the-art virtual-world technology to create subject matter for clinical medical learning. Pulse!! is a high-tech response to a coalescing host of adverse factors compelling innovative means to provide clinical experience and practical knowledge rooted in critical thinking, not only for degree-based education but also continuing education for medical practitioners.

Method

The Pulse!! learning platform looks and acts like a videogame. Users navigate the platform's three-dimensional space using a standard computer "mouse" and keyboard. The virtual space is totally navigable. Users interact with a high-fidelity virtual patient and with other virtual medical personnel to conduct examinations, order tests and administer medication. The virtual patient is modeled to respond accordingly and in real time.

Users in the beta field test completed demographic questionnaires at the beginning and reaction questionnaires at the end of their sessions. A subset were interviewed in detail to assess platform usability and recommend improvements to the design team.

Results

Participants in this study (n=23) were represent a variety of specialties and experience, from medical students through physicians. This sampling method ensured that the interface was usable across a variety of learners. Participants came from two teaching hospitals in the Northeast.

Our goal was twofold: to gather specific comments for necessary updates to the system; and to make a global assessment of participants' reactions. The first analysis yielded numerous recommendations for changes to the interface and simulation. These data were crucial to development of an "in-game" tutorial that now guides participants through use of the interface prior to initiating a case.

To assess participants' reactions, we collected data and asked participants to answer a series of open-ended questions. Our data indicated that the overwhelming majority (82%) of participants reacted positively to the Pulse!! platform. Over 80% reported that the platform held their interest. All but one respondent reported that the platform was visually appealing. These data suggest high motivation to learn in the Pulse!! platform.

A majority of participants reported that the system was easy to use. A majority of participants reported that the platform could provide training relevant to their jobs and that they would recommend Pulse!! to a colleague. Our expert (anecdotal) assessment was that most participants were able to interact effectively with the system after a few minutes of familiarization. We observed that the biggest challenge for participants with little or no video-game experience was navigating the virtual world).

Conclusions

Preliminary results indicate that the Pulse!! platform appears to be a viable environment in which to embed instruction. Participants responded well to the technology and expressed enthusiasm regarding its utility as a learning tool.

Relationship of Cybersickness to Posttraumatic Stress Disorder and Mild Traumatic Brain Injury in Military Personnel Enrolled in a Virtual Reality Graded Exposure Therapy Treatment Trial.

Jennifer A. Murphy, MA[1, a], Kristy B. Center, MA[1], Dennis P. Wood, PhD[1], Robert N. McLay, MD, PhD[2], Scott L. Johnston, PhD[2], Carol A. Russ, PhD[1], James L. Spira, PhD, MPH[1], Dennis Reeves, PhD[3], Brenda K. Wiederhold, MBA, PhD[1]

[1] Virtual Reality Medical Center, 6155 Cornerstone Court East, Suite 210, San Diego, CA 92121, www.vrphobia.com
[2] Naval Medical Center San Diego, Department of Psychiatry, 34800 Bob Wilson Drive, San Diego, CA 92134.
[3] Clinvest, 3805 S. Kansas Expressway, Springfield, MO 65890. ;

[a] JAMurphy@nmcsd.med.navy.mil

Background: Warriors returning from the combat theatres of Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) have been noted to have significant rates of mental health disorders such as posttraumatic stress disorder (PTSD). Additionally, mild traumatic brain injury (mTBI), is defined by the exposure to a head injury in conjunction with either alteration in consciousness and/or memory, this has been reported to affect nearly 15% of returning OIF/OEF soldiers. The relationship of mTBI and PTSD is complex due to high co-morbidity and several overlapping symptoms between the two conditions. Virtual reality graded exposure therapy (VRGET) has been shown to be an effective treatment for warriors returning from Iraq and Afghanistan that have been diagnosed with PTSD, including those cases complicated by mTBI. Previous studies have demonstrated that some individuals cannot tolerate virtual reality (VR) treatments due to the occurrence of cybersickness. Some of the risk factors for cybersickness include: fatigue, sleep disturbance, high anxiety, or disturbances in sensory, perceptual or vestibular systems, which are common in patients with PTSD and/or mTBI. Therefore, our aim was to describe the prevalence of cybersickness in a combat PTSD population, the relationship between PTSD symptoms, mTBI and cybersickness and the tolerability of VRGET with combat PTSD and mTBI.

Methods: As a part of the standard assessment battery for the larger VRGET study, the PTSD Checklist-Military (PCL-M) and a blast exposure questionnaire were administered to participants at baseline to assess for PTSD and mTBI, respectively. Of 37 persons assessed, 18 Military personnel were randomized to VR and sustained at least 5 sessions of VRGET treatment and were therefore administered the Simulator Sickness Questionnaire (SSQ) to assess for the occurrence of cybersickness symptoms during the VR portion of the treatment.

Results: Fifty-six percent of the participants met strict criteria for PTSD (n = 10). Half of the participants (n = 9) met criteria for mTBI. Increased PTSD severity, is determined by higher scores on the PCL-M, were positively correlated with increased cybersickness symptoms as determined by higher SSQ scores (r = 0.79, p = 0.00). Independent samples t-test analyses indicated a trend between higher SSQ scores and presence of mTBI (p = 0.08). When the presence of mTBI was controlled for, the relationship between cybersickness and PTSD was no longer significant (p = 0.30). Only 17% (n =3) of participants had to stop VRGET sessions at any time due to cybersickness symptomatology. There was no relationship found between intolerability of the VR and SSQ scores or presence of mTBI.

Conclusion: In this sample, those patients reporting greater severity of PTSD symptoms also reported greater amounts of cybersickness while immersed in a virtual simulation of their combat experience. Therefore, autonomic dysregulation found in PTSD might contribute to the occurrence of cybersickness. The presence of mTBI appears to mitigate this relationship, but its mechanism is not quite clear, perhaps due to the small sample size of this study. Contrary to previous findings, cybersickness did not decrease tolerability of the virtual environment in the patients in this sample.

An innovative project of Cyber-Clinic for children with ADHD : Impacts on diagnostic evaluation, treatment and clinical research

Véronique Parent, M.Ps.[1,2]
Marie-Claude Guay, Ph.D. [1,2]
Philippe Lageix, M.D. [2]
Jacques Leroux, M.D. [2]
Mélanie Rouillard, M.Ps.[2]

[1]*Université du Québec à Montreal*
[2]*Clinique des Troubles de l'Attention, Hôpital Rivière-des-Prairies*

Attention Deficit and Hyperactivity Disorder (ADHD) is one of the most important disorders in childhood. It affects approximately 5 to 9% of school age children and for an important proportion of those affected, the symptoms persist until adulthood resulting in difficulties of adaptation in school, social and family life (Comings, 2001). It is thus important to develop effective intervention strategies for this population and to continue clinical research, to aid in improving diagnostic evaluation and treatment. The cognitive remediation is an innovative approach in ADHD treatment and it aims to improve deficient cognitive functions with computerized exercises (Klingberg et al., 2002 ; 2005). One of the principal limits of this approach is its accessibility, directly related to the intensity of the treatment (3 to 4 times/week).

Our team of researchers and clinicians developed and established a unique and innovative model of Cyber-Clinic which on one hand, aims to improve the quality and the accessibility of the clinical services offered and, on the other hand, to facilitate and to multiply the activities of clinical research on the diagnostic evaluation and on the treatments offered to the children with ADHD.

The main objective of this presentation is to explain the functions of the four components of the Cyber-Clinic that are accessible by the Internet for all the patients, their parents and the healthcare professionals involved in the treatment.

The first component is a unit of control of files which, among other things, allows the personal information of each patient involved to be recorded and updated into the system.

The second component is a unit of control of the evaluations which allows digitizing all the data relating to the diagnostic evaluation. This includes the results of the behavioural questionnaires and the results of the neuropsychological measures of our standardized procedure for assessment. The neuropsychological measures make it possible to evaluate the cognitive deficits associated with ADHD.
The third component allows the control of the treatment by the setting in network of the computerized exercises of cognitive remediation. Thus, the patient can easily have access to his intervention of cognitive remediation, at school or at home. Moreover, the therapist can easily follow the progression of his patients because all the data associated with the cognitive remediation programme are recorded on the website of the Cyber-Clinic.

The last component of our Cyber-Clinic is a data base. The data is recorded automatically from the three other components. Thus, for all the patients of the Cyber-Clinic, all the data associated with the diagnostic evaluation and the cognitive remediation treatments are compiled. In sum, this new technology makes it possible to multiply the possibilities of clinical research with children with ADHD.

Presence as cognitive process: the link between Self, intention and action

Giuseppe RIVA

Applied Technology for Neuro-Psychology (ATN-P) Lab., Istituto Auxologico Italiano, Milan, Italy
Interactive Communication and Ergonomics of NEw Technologies (ICE NET) Lab., Università Cattolica del Sacro Cuore, Milan, Italy,

Abstract: In this chapter we will present a conceptual framework that uses the concept of "Presence" – *the feeling of being and acting in a world outside us* - to link the enaction of our intentions with the understanding of other people's intentions. Specifically we suggest that humans develop intentionality and Self by prereflexively evaluating agency in relation to the constraints imposed by the environment (Presence): they are "present" if they are able to enact in it their intentions. This capacity also enables them to go beyond the surface appearance of behavior to draw inferences about other individuals' intentions (Social Presence): others are "present" to us if we are able to recognize their intentions. Both Presence and Social Presence evolve in time, and their evolution is strictly related to the proposed by Damasio (Proto-Self, Core Self, Autobiographical Self). We can identify higher levels of Presence and Social Presence associated to higher levels of intentional granularity: the higher is the level of Presence and Social Presence experienced by the Self, the higher is the complexity of the expressed and recognized intentions. Furthermore, Presence and Social Presence converge within the social and cooperative activities. In particular, is through their interaction that the Self improves his intentional action and interaction: the higher is the Presence and Social Presence experienced during narrative/interactive practices, the more is the possibility that the goals and motives of the narratives/interaction will be internalized.

NeuroVR 1.5: A Free Virtual Reality Platform for Clinical Psychology and Behavioral Neurosciences

Giuseppe RIVA [1-2], Andrea GAGGIOLI [1-2], Alessandra GORINI [1], Riccardo CORSI [3], Gianluca FALETTI [3], Luca VEZZADINI [3]

[1] Applied Technology for Neuro-Psychology Lab,
Istituto Auxologico Italiano, Milan, Italy
[2] ICE-NET, Università Cattolica del Sacro Cuore, Milan, Italy
[3] VR Department, Virtual Reality & Multi-Media Park, Turin, Italy

Abstract. Virtual reality (VR) can be considered to be an embodied technology whose potential is wider than the simple reproduction of real worlds. By designing meaningful embodied activities, VR may be used to facilitate cognitive modelling and change. However, the diffusion of this approach is still limited by three main issues: poor usability, lack of technical expertise among clinical professionals, and high costs. To address these challenges, we introduced last year NeuroVR (http://www.neurovr.org – http://www.neurotiv.org), a cost-free virtual reality platform based on open-source software, that allows non-expert users to adapt the content of a pre-designed virtual environment to meet the specific needs of the clinical or experimental setting. Following the feedbacks of the users we developed a new version – NeuroVR 1.5 – that improves the possibility for the therapist to enhance the patient's feeling of familiarity and intimacy with the virtual scene, by using external sounds, photos or videos. Specifically, the new version now includes full sound support and the ability to trigger external sounds and videos using the keyboard. The NeuroVR platform runs on standard personal computers with Microsoft Windows; the only requirement for the hardware is related to the graphics card, which must support OpenGL.

What would influence mental health professionals working in Native / First Nations reserves to refer their patient to telepsychotherapy services?

Geneviève Robillard, M.Sc., Stéphane Bouchard, Ph.D., & Monique Séguin. Ph.D.
Université du Québec en Outaouais

genevieve.robillard@uqo.ca

Context:
The Technology Acceptance Model (TAM; Davis, 1989, 1993; Venkatesh, 2000) is a well-known theory suggesting that two major factors contribute in the intention of using a specific technology: a) the Perceived Ease of Use and; b) the Perceived Usefulness. Bertrand and Bouchard (2007) adapted and tested how the TAM applies to the use of virtual reality (VR) in mental health settings. Using Structural Equation Modeling with data collected on 141 professionals using VR, they found that intention to use VR is essentially predicted only by the perceived usefulness of this technology. Their results are somewhat surprising given the impression shared by many researchers in the field of VR that others factors would play a significant role, such as costs, perceive self-efficacy to use the technology, attitude towards VR or computer anxiety. Would these unexpected findings also be found in telehealth, especially with professional who are not yet familiar with the technology involved?

The aim of the study is explore factors related to the intention of referring their patients to videoconference-based telepsychotherapy among mental health professionals working on Natives / First Nations reserves. A paper and pencil version of Bertrand and Bouchard's questionnaire was reworded to be applied to videoconference technology and used in the present study.

Method:
A full-day workshop on pathological gambling was offered in 12 different Native / First Nations reserves in the province of Quebec. After the workshop, 76 mental health professionals working in the community agreed to complete a questionnaire about telepsychotherapy. Most of the sample consists of women (74,5%). About half of the sample is aged between 40-59 years (43.1%) and speaks French (52.7% French; 47.3% English). Participants have a variety of training or professional background: social workers (30%), nurses (3.6%), psychoeducators (2.7%), etc. The study is still underway as we are targeting a sample of 180 participants (a goal that will be reached in the next few months) spread over 27 reserves.

Results:
The internal consistency of each scale is excellent (Cronbach's α ranging from 82 to .97). Results from a multiple regression analysis [$F_{(4,73)} = 30.67$, $p < .001$, $Adj.R^2 = .64$] show that the Perceived Usefulness ($\beta = .40$, $t = 3.78$, $p < .001$, $sr^2 = .27$) and the Perceived Ease of Use ($\beta = .38$, $t = 2.66$, $p < .01$, $sr^2 = .19$) are both predictors of the intention to use telehealth with their patients. Comfort and therapists attitude towards telehealth were not significant predictors in the regression.

Discussion:
Our preliminary results confirm Bertrand & Bouchard's (2007) findings that perceived usefulness is a key predictor, over and above more personal variables such as attitude towards the technology. However, as proposed in the original TAM model, perceived ease of use seems to also play a significant role as well. Our results suggest that we need educate professionals on how videoconferencing can be a useful tool that is easy to use instead of putting our efforts on factors such as costs or attitude toward the technology.

Road Civil War: Treating a MVA victim with virtual reality - a case study.

Tomaz Saraiva[1], Pedro Gamito, PhD[1], Jorge Oliveira, PhD[1], Diogo Morais, PhD[1], José Miguel Pombal, PhD[1]

[1] University Lusofona of Humanities and Technologies

maveryck21@hotmail.com

Motor Vehicle Accidents (MVAs) are a serious concern in the western part of Europe, especially in Portugal, where the figures in 2007 alone ascend to 99,685 accidents, 31,000 injuries and 741 dead. Therefore, the scope of this project is to develop a virtual reality (VR) application which can be used to treat MVAs victims that developed Post-traumatic Stress Disorder (PTSD) or Acute Stress Disorder (ASD), after the traumatic event. This paper presents the results of the first clinical trial in a psychiatric hospital in Lisbon, with a 42-year old female; over a 12 session VR graded exposure therapy. The patient was exposed through a trans-lucid screen to a virtual highway with an increasing anxiety triggering events (traffic intensity; horns; proximity of the surrounding buildings; tunnels; crossovers). PTSD was diagnosed through a structured clinical interview for DSM-IV (CAPS). The patient was evaluated through psychophysiological (ECG; GSR) and self-report measures (IES, ITC-SOPI and HADS). The results indicated that the patient had a severe decrease in PTSD symptoms, namely in the IES (Intrusion and Avoidance dimensions) and in the HADS (Anxiety and Depression dimensions). As far as the psychophysiological activation concerns, the distribution GSR and ECG values during the 12 sessions followed the expected pattern being reduced during the final session with statistically significant differences between sessions for ECG ($F(11) = 2.842$; $p < .05$). However, the most relevant fact is that this decrease led to the patient being able to drive again.

Keywords: MVA, PTSD, VR exposure, Psychophysiology.

Development of Simulated Auditory Hallucination Exposure Environments: Pilot Study

YoungSeok Shin[1], M.S. candidate, Jeonghun Ku[1,], Ph.D., Kiwan Han[1], Ph.D. candidate, HyeongRae Lee[1], Ph.D. candidate, JinSick Park[1], Ph.D. candidate , YouKyoung Choi[2], M.A., Il Ho Park[2], M.D., Jae-Jin Kim[2], M.D., Ph.D., In Young Kim[1], M.D., Ph.D., & Sun I. Kim[1], Ph.D.*

[1]Department of Biomedical Engineering, Hanyang University, Seoul, Korea
[2]Institute of Behavioral Science in Medicine, Yonsei University Severance Mental Health Hospital

xzerostone@bme.hanyang.ac.kr

Schizophrenia is a brain disease, which affects general cognitive functions as delusion, hallucination, thought disorder, blunted expression of emotions, social withdrawal, and awareness of confusion. Auditory hallucination is among the symptoms of schizophrenia that designates the phenomenon that someone hears or seems to hear when even the sound does not exist.

Patients with schizophrenia could be disturbed by the sounds that are irrelevant to a real situation such as auditory hallucination, while healthy people can ignore properly those sounds. Conventional therapies for treating hallucination were used with medication and cognitive behavior therapy. But, in conventional cognitive behavior therapy, it is very difficult to simulate the stimulus of such an auditory hallucination. In addition, there are some problems about nonobjective assessments due to the dependence of the therapist's ability to assess the patient's state or training effectively. Virtual Reality (VR) techniques could overcome these shortcomings. Especially, they can simulate the auditory hallucination with controlled 3D virtual environments by generating irrelevant sound stimulation. Therefore, in this study, we developed the VR system to present an effective auditory hallucination stimulus and to measure the subject's response to simulated auditory hallucinations. The developed VR system consisted of a PC, head mounted display (HMD), orientation tracking sensor, and a joystick. Virtual environment tasks consisted of four situations: 'errand to the grocery store', 'packing for travel', 'having medical treatment at hospital', and 'getting order and serving at fast-food store'. Auditory hallucinations were provided during each task. Four healthy participants (3 male and 1 female) were recruited. Movement pathway (trajectory), performance time (during experience each situation), and the number of simulated hallucinations were obtained during participant's experience of the developed virtual reality system. Moreover, Launay-Slade Hallucination Scale (LSHS) and the hallucination experience scale (asking understanding about auditory hallucination) was answered after the experiences. In the results, there was positive correlation between the LSHS score, performance time and the number of simulated hallucinations. Hence, it could be explained that the participant who shows more proneness to auditory hallucination are more influenced by the simulated auditory hallucinations in virtual reality, and the participants show more understanding about auditory hallucination after experience of virtual reality system than before experience. It can be considered that the developed virtual reality systems can provide effective auditory hallucinations and assessment of behavioral characteristic about the hallucination. This is a pilot study for the development of an auditory hallucination exposure system using virtual reality. A follow-up study will be about clinical experiment with schizophrenia group for verifying cognitive behavioral characteristic to auditory hallucination.

Keyword: Virtual Reality, Auditory Hallucination

** Corresponding author.*
Jeonghun Ku, Ph.D.
Assistant Professor
Department of Biomedical Engineering,
Hanyang University, Seoul, Korea
Tel.: +82-2-2298-8920; Fax: +82-2-2296-5943
E-mail: kujh@bme.hanyang.ac.kr

The Influence of mTBI on Autonomic Dysregulation in Combat Veterans with PTSD

James Spira, PhD, MPH[1]; Brenda Wiederhold, PhD, MBA[1]; Kristy Center, MA[1]; Jenifer Murphy, MA[2, a]; Robert McLay, MD[1]; Dennis Wood, PhD[1]; Mark Wiederhold, M.D.[1]

[1]Virtual Reality Medical Center, 6155 Cornerstone Court East, Suite 210, San Diego, CA 92121, [2]Naval Medical Center San Diego, Department of Psychiatry, 34800 Bob Wilson Drive, San Diego, CA 92134

www.vrphobia.com

Navy and Marine veterans of OIF/OEF who were referred to treatment with a diagnosis of PTSD were assessed at baseline (N=37) and post-treatment follow-up (N=9) for psychophysiological reactivity and PTSD symptoms. Psychophysiological measures (Skin Conductance and Heart Rate Variability) were assessed across three, five-minute conditions: Baseline, Stress Recall (tell us about the most disturbing memory of your most recent deployment), and Recovery (please sit quietly for the next five minutes). About half of the PTSD patients assessed and treated reported blast exposure (N=18), with a sub-set exposed becoming dazed and confused (N=8), and a sub-set of those having memory temporary loss (N=4). Cumulative blast complications were scored as "0" (no exposure), "1" (blast exposure), "2" (blast exposure plus being dazed and confused), and "3" (blast exposure, dazed and confused, and memory loss).

Pre-treatment Analysis: Repeated measures ANOVA revealed that patients at time 1 became aroused with stress recall, but were unable to reduce arousal during the recovery phase ($p<.0001$), with arousal in fact continuing to increase during the recovery phase ($p<.007$). A Blast Exposure x Condition at time 1 indicated that the increase in SC scores during recovery was found for PTSD patients exposed to blast, but not for non-blast exposed PTSD patients ($p<.05$). Further, the more effects of blast (exposure, dazed and confused, memory loss) the greater the autonomic dysregulation (SC and HRV), and the less likely to be able to recover, compared to those with no blast exposure.

Post-treatment Analysis: This difference was not found following Virtual Reality Assisted Graded Exposure Therapy (VRGET), this indicated that this type of treatment was successful in training patients with combat PTSD in autonomic control in the face of a stress recall, and facilitating the ability to reduce arousal following stress. Further, cumulative blast score was directly correlated with SC at recovery at time 1(Spearman's rho=.448; $p<.05$, N=20) indicating poor pre-treatment recovery of SC, yet this was not found at time 2 ($r=.281$, $p<.542$, N=7), signifying that blast no longer had an influence on SC recovery following VRGET treatment.

Pre-Post Analysis: Repeated measures *Condition* (baseline, stress recall, and recovery) x *Time* (pre post intervention) ANOVA (N=9) revealed: 1) a significant difference for Condition ($F=9.06$; $p<.017$; Partial Eta Squared =.531 with observed power of .751), 2) a significant difference for Time ($F=5.97$; $p<.04$; Partial Eta Squared = .427 with observed power of .574), and 3) a Condition x Time interaction ($F=13.12$; $p<.007$; Partial Eta Squared = .622 with an observed power of .887). This shows that there was a statistical and clinical significant difference in response to stress recall and recovery over time. Subsequent analysis showed that even though patients had no change in baseline SC over time, patients had significantly greater control over reactivity during stress recall and recuperation than they did at time one (see analysis, below). Patients at time-2 had 57% greater recovery than patients did at time-1. A simple regression demonstrated that cumulative blast score predicts baseline SC, stress recall SC, and recovery SC levels ($p<.05$ at time 1), but only predicts SC baseline at time 2, not stress or recovery. Hence, while blast patients may continue to have higher baseline SC values, they have learned how to control their autonomic reactivity following treatment.

Conclusion: While PCL-M scores decreased significantly from pre to post treatment ($p<.001$), there was no correlation between physiological arousal and any other PCL-M subscale or total score. This may indicate that objective physiological arousal is not always associated with conscious cognitive arousal. PTSD patients with blast exposure had higher arousal during stress recall, and still higher arousal during

Lessons learned from treating 200 motor vehicle accident victims with videogames.

David Walshe, M.A. Psychol, MB., B.A.O., BCh,. MRCPsych,. M.Med Sc.

St Stephens Hospital Cork/University College Cork.

davidgmw@yahoo.com

There are practical and safety issues when using Exposure Therapy (ET) *in-vivo* in the treatment of driving phobia following after a Motor Vehicle Accident (MVA) and a literature review suggests that this is rarely used as a treatment modality. At Cork, we developed a driving simulation programme based on the use of driving videogames projected onto a large screen (VRET) and published data supporting its use. We have continued to use this programme over the past 6 years and here reflect on 'lessons learned'.
The last 50 consecutive patient charts were reviewed to confirm clinical impressions.

Some Observations.

1. Driving phobia for MVA victims is almost invariably an 'Accident Phobia' and should be treated accordingly.
2. There are usually 2 components to the phobia, a fear of driving and a fear of passenger travel. Both aspects of the phobia require treatment with the number of hour-long treatment sessions required ranging from 3-20. (Average 7 sessions.)
3. Most patients immerse with suitable driving videogames as noted by the induction of an anxiety reaction. Videogames provide a more suitable medium than VR and the software is better and cheaper for simulating driving accidents.
4. Most patients have more than one diagnosis e.g. P.T.S.D., G.A.D., Major Depression, Panic Disorder will slow progress unless it is treated; Medication is often useful in treatment of these disorders.
5. You can lead a horse to water but you can't make it drink… The patient must be motivated to return to driving or you will fail. Need to set realistic targets.
6. In trauma work litigation often a stumbling block to successful treatment but to a lesser extent with phobic patients.
7. Some patients find simulations too immersive with marked anxiety/panic reactions that do not readily habituate despite prolonged exposure. DVD's/ Videotapes a useful adjunct to therapy.
8. Most patients respond to treatment but often a residue of fear remains. Do not oversell the programme.

These and other observations will be illustrated with clinical cases.

Combat related Post Traumatic Stress Disorder and Mild Traumatic Brain Injury in Naval Personnel Deployed to Iraq and/or Afghanistan in Support of Operation Iraqi Freedom and/or Operation Enduring Freedom: A Retrospective Study (1;2)

Dennis Patrick Wood, Ph.D. (3); Jenny Murphy, M.A. (4); Kristy Center, M.A. (4); Jim Spira, Ph.D. (5); Martin Holland, M.D. (6); Carol Russ, Ph.D. (5); Robert McLay, M.D., Ph.D. (7); Dennis Reeves, Ph.D. (8); Robert Koffman, M.D. (9) and Brenda K. Wiederhold, Ph.D. (10)

(1) The opinions expressed are the private ones of the authors and should not be considered approved or representative of the Navy Medical Department, the Office of Naval Research or the Department of Defense.

(2) This study was sponsored by the Office of Naval Research (ONR) Contract (#N00014-05-C-0136) to Virtual Reality Medical Center San Diego, CA.

(3) Clinical Psychologist, Virtual Reality Medical Center, 6160 Cornerstone Court East, #155, San Diego, CA 92121; 619-992-8586; dpwcapt@aol.com.

(4) Research Assistant, Virtual Reality Medical Center, 6160 Cornerstone Court East, #155, San Diego, CA 92121; 858-642-0267.

(5) Clinical Psychologist, Virtual Reality Medical Center, 6160 Cornerstone Court East, #155, San Diego, CA 92121; 619-992-8586.

(6) Staff Neurosurgeon, Naval Medical Center San Diego, Department of Neuroservices 34800 Bob Wilson Drive, San Diego, CA 92134.

(7) Staff Psychiatrist, Naval Medical Center San Diego, Department of Psychiatry, 34800 Bob Wilson Drive, San Diego, CA 92134.

(8) Vice-President, Clinvest, 3805 S. Kansas Expressway, Springfield, MO 658907; 417-841-3662.

(9) Navy Combat and Operational Stress Control Consultant, Bureau of Medicine and Surgery, 2300 E Street NW, Washington, DC 20372-5300.

(10) Executive Director, Virtual Reality Medical Center, 6160 Cornerstone Court East, #155, San Diego, CA 92121; 619-992-8586.

Posttraumatic stress disorder (PTSD) is one of the most disabling psychological conditions affecting the veteran population. The percentage of Army and Marine Corps personnel who participated in combat during Operation Iraqi Freedom or Operation Enduring Freedom between March and October 2003, who met screening criteria for major depression, generalized anxiety disorder or PTSD, ranged from 11.2% to 17.1%. VA officials have reported 20% of Iraq veterans who have sought VA health care for mental health issues. The Veterans' Administration expects these numbers to grow since many discharged veterans, who suffer Post-traumatic Stress Disorder and other mental health illnesses, have not yet sought care. Of the 168,000 service members who have served in Iraq and have been discharged as of July 2004, about 28,000 had sought medical care from the VA; of these, about 5,400 service members reported the presence of mental health issues and nearly one-in-three of these 5,400 suffered from PTSD. It has also been reported that 12% of U.S. soldiers hospitalized following serious combat injury in Iraq were diagnosed with PTSD at 7 months following their hospitalization. Higher PTSD rates have been anticipated among troops who have been deployed to Iraq more than once.

The recent report of the President's Commission on Care for America's Returning Wounded Warriors concluded that PTSD occurred in 6 – 11% of veterans serving in OEF and in 12 – 20% of OIF veterans. This Report also concluded that it was not known how many service members have suffered a mild TBI that went undiagnosed. However, among 35,000 otherwise health service members returning from deployment who were screened for TBI, up to 20% screened positive for having experienced a mild TBI while deployed. The President's Report recommended that the DOD and VA should aggressively prevent and treat PTSD and Traumatic Brain Injury. Early treatment is imperative in order to maintain personnel on active duty and to reduce the future burden of the Veterans Administration (VA) healthcare system.

Another report has suggested that 20,000 U.S. troops, who have served in Iraq and Afghanistan, have been found with signs of brain injuries or TBI. Most of these brain injuries have been classified as mild or moderate and have commonly been secondary to exposure to blasts. Given their severity, penetrating TBIs are cared for immediately. Closed TBIs, on the other hand, frequently go unrecognized and undiagnosed. This is especially the case with mild TBI. Of note, any TBI can result in short- and long-term disabilities. Importantly, for a combat veteran with a brain injury of any severity, the combination of cognitive and emotional compromise of PTSD can negatively affect recovery. Hence, quickly and properly diagnosing the presence/absence of PTSD and/or TBI in U.S. troops who have been deployed to the combat zone is conforming with the not only the recommendations of the President's Commission on Care for America's Returning Wounded Warriors but it is in the best interests of our warriors.

Virtual Reality Medical Center of San Diego has been awarded an Office of Naval Research (ONR) grant to complete a randomized study, at the Naval Medical Center San Diego and Navy Hospital Camp Pendleton, comparing the effects of Virtual Reality Graded Exposure Therapy (VRGET) with Cognitive Behavioral group therapy. To meet the guidelines for this study, VRMC has completed the pre-treatment assessment of 40 Naval personnel who have been deployed to the Iraq and/or to the Afghanistan combat theaters since March 2003 and who were initially diagnosed with PTSD. Many of these 40 Naval personnel were also exposed, one or more time, to blast injury during their combat deployment.

This presentation will review not only the assessment protocol for the VRMC/ONR funded study to treat combat-related PTSD with VRGET, but will also review the clinical results for the assessed personnel in terms of presence/absence of PTSD and presence/absence of TBI. Lastly, we will make suggestions concerning the future assessment of combat-veterans experiencing disabling conditions, secondary to having served in a combat zone, best described as PTSD and/or TBI in order to better maximize the accuracy of their diagnosis, facilitate their integrated and aggressive coordinated care, and the speed of their recovery.

Effects of Stereoscopic Displays and Interaction Devices on Human Motor Behavior

Shih-Ching Yeh[1], Ph.D candidate, Belinda Lange[2], Ph.D, Alexander A. Sawchuck Ph.[1] & & Albert 'Skip' Rizzo[2], Ph.D.

[1]Integrated Media Systems Center, University of Southern California, Los Angeles, CA
[2]Institute for Creative Technologies, University of Southern California, Los Angeles, CA

Personal computers (PC) and video games provide intensive practice and unlimited repetition along with ongoing feedback, which has been explored as a therapeutic tool to retrain faulty movement patterns resulting from neurological dysfunction. However, real human performance or behavior might be biased because of the nature or limitation of interaction devices or displays. Designing an immersive virtual environment with enabling technologies composed of various display (rendering) systems, sensing systems, haptic devices or game features, and the mechanism of interaction between human and computer systems is highly sophisticated. The separation of actual human performance from behavior imposed by the computer system is significantly important, especially if it is applied to people with disabilities or motor impairment. The goal of this research was to compare the performance of different stereoscopic displays and tracking/interaction devices in the context of motor behavior and interaction quality within various Virtual Reality (VR) environments. Participants were given a series of VR tasks (ball catching, depth test, spatial rotation, reaching test) that required motor behaviors with different degrees of freedom. The VR tasks were performed using a monoscopic display, shutter glasses and an autostereoscopic display and two tracking devices (optical and magnetic). The two 3D tracking/ interaction devices were used to capture continuous 3D spatial hand position with time stamps. Fifty participants completed questionnaires that evaluated display comfort and the simulation fidelity of the three displays, along with the efficiency of the two interaction devices. Motor behavior was also measured using motion tracking data. Participants completed two tasks (depth test and ball catching) using each of the three displays and three tasks (depth test, reaching test and spatial rotation) using the two different tracking devices in random order. Participants completed the ball catching and depth test tasks faster when using shutter glasses than the other two displays. Participants rated the autostereoscopic display the highest for discomfort and eyestrain and the least satisfactory overall. When using the autostereoscopic display, participants could have had difficulty maintaining a good 3D stereo picture when playing the VR game tasks due to the requirement of having to keep head movements within the limited area ("sweet spot") where 3D stereo can be seen. Overall, the optical and magnetic tracking devices scored highly in the user perception questionnaire for all tasks. The optical tracker also performed as well as magnetic tracking system for game tasks requiring motion within three degrees of freedom. However, participants were slower completing the game tasks that required motion within six degrees of freedom when using the optical tracker. These preliminary results suggest that the use of shutter glasses provides a more immersive and user-friendly display than monoscopic and autostereoscopic displays. The results also suggest that the optical tracking device, available at a fraction of the cost of the magnetic tracker, provides similar results for users in terms of functionality and usability features. The findings of this study can be considered when developing VR based systems for use in research involving 3D interactive games for motor rehabilitation techniques.